POWER

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PHILIP W. SWAIN, *Managing Editor*

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WHY?

Acres of Diamonds (see cover). Famine in the Land of Plenty (page 582). Public Improvements at Zero Cost (page 510, October). Read these three slants on an ever-present problem and then try to answer the following questions:

I—*Why do industrialists* (America's "keen, hard-headed industrialists") burn the midnight oil for sales, fight to the finish for every little contract, run a penny-picking vacuum cleaner through shop and office—and then gaze in serene content at obsolete power equipment that is wasting thousands yearly, wasting the *profits* on hundreds of thousands of dollars of sales?

II—*Why do taxpayers* everywhere groan at their burdens, driving city, state and Federal officials to clip, clip, clip until it hurts even the taxpayers —while they (both taxpayers and officials) refuse to lower taxes painlessly by eliminating power-service wastes in public buildings?

III—*Why do the owners* and operators of large private buildings spend long hours proving the impossibility of operating at a profit—while power-service wastes frequently exceed the annual deficits? Why do they get excited at Wall Street tips one day and on the next turn the cold shoulder to a fifty-per cent return on gilt-edged power investments under their own roofs?

An engineer may properly ask these questions. He cannot answer them, if he believes that business men are rational beings, unless he admits that the possibilities have not been rightly presented.

Have consulting engineers and operating engineers presented the real facts to those with power to act—and veto action? Have they made these facts clear to the non-technical business mind? Have they been believed? And if not, why not?

Building Management?

● In his scathing article on page 582, L. E. Habben talks turkey on power-service wastes in city buildings. Author and reader alike ask why such conditions exist. This question Mr. Habben answers in part, but he omits one significant point:

Practically all the large buildings are in the hands of so-called "management companies," who receive payment on a basis of actual receipts. Either these companies are not sufficiently interested, or they do not possess the necessary talent to make a really detailed study of these problems.

Whatever the excuse, it is clear that much of the blame for present wastefulness is chargeable to the management companies.

What Life?

● Depreciation is an estimate; obsolescence a guess. Who knows what Jim Smith of Oshkosh may invent in 1942?

There is much evidence that power equipment is written off too slowly. Engineering progress has been more rapid than was expected. Will this rapid rate hold up? We guess yes.

This raises a practical point. If today's power equipment will become obsolete before it wears out, why should maker and user pay the cost of this useless durability? Why not take a tip from Detroit? Both maker and user profit because automobiles are not built to last forever.

Come and Get It!

● "The balance of the public works money, nearly all of it intended for state or local projects, waits only on the presentation of proper projects by the states and localities themselves. Washington has the money and is waiting for the proper projects to which to allot it."

These are the words of President Roosevelt himself, part of his Oct. 22 radio speech. In plain English, he tells you that Washington is still trying to give away twelve hundred million dollars. States and cities are invited to "come and get it" for projects that pass the required test.

To date few grants have been made for modernization of mechanical equipment in public buildings. State and city authorities ask for what they think they need. Who except local engineers can show them how taxes can be reduced by eliminating power-service wastes in public buildings?

Write *Power* today for a free copy of "Public Improvements at Zero Cost." Then take the initiative in creating an engineering boom in your own state and your own home town.

Stamp of Quality

● "M. E." does not really mean "Mechanical Engineer"; professional competence requires much more than a college degree.

The present lack of any trustworthy official recognition of professional growth beyond graduation is unfair to those who have earned such recognition. It is unfair also to those who would fight to reach a higher goal if they could see it.

In proposing to develop definite plans for the "adult education" and certification of practicing engineers, the Engineering Council for Professional Development (see page 576) has started something really worth while.

Spread Eagle

● Some folks miss the meaning of the blue-eagle campaign. The real idea, a smart one, is that NRA's flapping wings will scare off the "big bad wolf" while Mrs. Eagle is hatching a nestful of code eggs back in the Washington nest.

Already more than fifty codes have become law by the President's signature. The rest will come through in a hurry, probably another hundred by the middle of November. As fast as they are adopted, these codes automatically replace the temporary blue eagle "agreements." They give to American industry the long-sought chance to clean its own house, to control its own affairs.

Those who fear that American initiative will ultimately be stifled by a Washington bureaucracy, will have only themselves to blame if this happens. NRA offers each industry the *chance* to govern itself under its code.

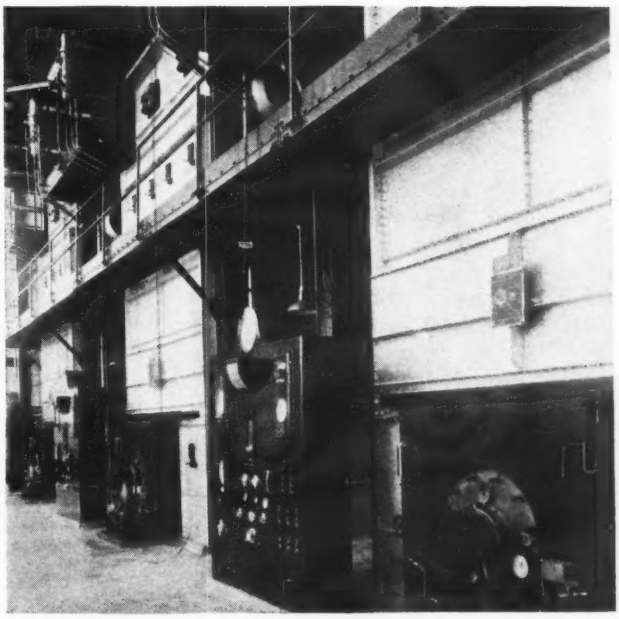
POWER Stands for

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of By-product Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

FORSTMANN WOOLEN
. . . ADDS POWER GENERATION
. . . SCRAPS OLD BOILER PLANTS

BY F. L. BRADLEY
Superintendent of Construction
Forstmann Woolen Co.

New plant outside manufacturing area has fewer and more efficient units than two old plants it replaced. It supplies process steam at three pressures and adds power generation



Burners on each boiler may be supplied from either of two mills

ON FEB. 21, 1933, the two existing boiler plants of the Forstmann Woolen Company Finishing Plant were removed from service. These old plants were replaced by one new plant having fewer and more efficient steam generating units designed and constructed by the Engineering Department and Construction Division of the Forstmann Woolen Company, under supervision of Messrs. C. J. Schlachter and F. L. Bradley. A turbine room with electrical bay has since been added, completing the Passaic power plant.

The site selected is in Clifton, N. J., on the Passaic River. To provide space for the construction of new manufacturing buildings the plant was located adjacent to, but outside, the immediate manufacturing area. Proximity of the new industrial water main of the Passaic Valley Water Commission offered a satisfactory supply of water for boiler feed and service requirements. The Passaic River supplies the water for condensing and raw water uses.

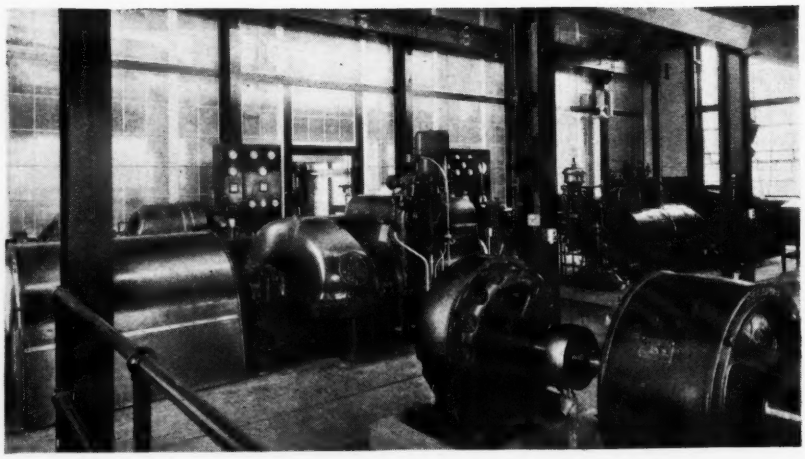
Two independent engineering and economic analyses of the power and steam requirements of the finishing plant demonstrated the desirability of replacing the existing steam and power facilities. These analyses were made in conjunction with a similar study of the power and steam problem in the Forstmann Woolen Co.'s Garfield Plant located across the Passaic River from the Passaic Plant. Several schemes were considered (a) separate power plants for each mill, (b) generation of steam and purchase of power, and (c) a steam plant in each mill, with generation of power for both mills at the Passaic Plant and transmission to Garfield by a tie line. The plan to construct two separate power plants was chosen because of its economic and physical advantages over those of other possible arrangements.

When designing the Passaic plant, serious consideration was given to the load factor, its characteristics and the equipment best suited for its requirements. The manufacturing plant required dry saturated steam at three different pressures, namely, 100, 30 and 10 lb. per sq.in. gage. Financial and physical difficulties encountered in attempting to provide one general steam pressure for the entire plant were too great to consider, due to the necessity of altering both considerable existing equipment now using 100. lb steam and the major portion of the plant heating system now requiring 10 lb. steam. It was decided, therefore, to use 250 lb. per sq.in. pressure at the boilers, inasmuch as this permitted generation of the entire manufacturing power requirements with maximum steam extraction at 35 lb. per sq.in. for process requirements, and also provided economic transportation of steam to distant points in the manufacturing area. By establishing a common 35-lb. system for both extraction and auxiliary exhaust, steam can be taken as required for feed water and process water heating and any excess exhaust automatically disposed of to the mill.

The power station building is constructed of selected common red brick and the interiors of the boiler and turbine rooms are finished with a selected common red brick laid up in simple design without ledges and dirt collecting corners. The walls have been painted cream for greater diffusion of light, and have a dark green dado

with concrete sanitary base to promote cleanliness.

The west end of the boiler room has been developed to provide for a battery room, an office and toilet and locker facilities. A water treating plant is located in an extension to the east end of the boiler room, and houses all the water treating and water storage facilities for the power plant and process requirements. A laboratory for continuous sampling and testing of river, city, treated and deaerated water, as well as steam samples has been provided in this section of the plant.



A glass partition separates the boiler and turbine room

An electrical bay on the south side of the turbine room is arranged with switchboard panels on the main operating floor and all circuit breakers and distribution equipment in a separate, completely enclosed, room below the switchboard panel. This arrangement places all the control equipment under the supervision of the turbine room attendant, eliminates unnecessary traffic in the oil circuit breaker room, and provides ample space for work on the electrical equipment when necessary.

The coal storage plant has been designed to provide a bunker capacity of 450 tons and a yard storage capacity of approximately 1,500 tons. Run-of-mine coal is delivered by rail to a track hopper. An apron conveyor feeds the coal from the hopper to a 90 ton per hr. crusher from where it is discharged to an 18-in. rubber inclined belt conveyor of 50 ton per hr. capacity for delivery to the bunker or to the outside storage.

To reduce "dead" space in the bunkers to an economic minimum, three outlet spouts per boiler have been provided, arranged to discharge to a coal scale where the weight of fuel to each boiler is recorded. Control of coal feed is effected by a d.c. motor driven table-type feeder located in front of each boiler, on the operating floor. The coal discharges by gravity to the pulverizers of the Atrita type located in the basement. This location for the pulverizers was chosen to avoid expensive supports, eliminate objectionable vibration, and to provide space and facilities for maintenance. Each pulverizer discharge is cross connected to serve one other boiler unit besides its normal boiler. Hot primary air is taken from the forced-draft system and is used to dry the coal in the pulverizers. The coal is burned in one flare-type burner per boiler which is provided with an oil burner for ignition and low load requirements.

There are three bent tube boilers designed to deliver steam at 250 lb. pressure and 100 deg. superheat. Each boiler is 17 tubes wide and has one dry steam and three water drums and has a rated capacity of 60,000 lb. of steam per hour.

The boiler drums are fusion welded and provided with protection against corrosion by the application of Apexior to boiler drums, tubes and water walls. The superheaters are single pass of the convection type located above the second row of boiler tubes, and contain approximately 230 sq.ft. of superheating surface. Steam entrance ends of the super-heater tubes are rolled into the dry steam drum and extend over its entire length, thereby providing even distribution to the superheater.

Each furnace is water cooled throughout, having bare tubes, except for that portion of the side walls near the burners where refractory covering has been used to effect more efficient combustion conditions at lower ratings. The side and rear walls of the boiler setting are made up of 2-in. shiplap refractory tile, backed up with 2-in. thick Super-X block insulation, and the entire unit is totally enclosed with steel casing arranged in panels. The front wall is of similar construction, except that instead of shiplap tile a solid refractory wall backed with Super-X insulation has been provided.

Both the forced and induced draft fans are on a fan floor above the boilers. This is not only the most logical arrangement, but also saves additional heat by utilizing the warm air naturally collecting at this point. Each boiler is provided with one forced- and one induced-draft fan. The forced-draft fans have a capacity of 20,000 c.f.m. at 80 deg. against 7.6 in. water pressure, and the induced draft fans each have a capacity of 36,200 c.f.m. at 350 deg. against 8.8 in water pressure Each fan is driven by a steam turbine with speed regulation by combustion control equipment which acts directly on the turbine governor valve.

The air preheaters are vertical, single pass, tubular type heaters, having approximately 5,660 sq.ft. of heating surface. No soot blowers have been provided for this equipment.

Fuel feed, forced- and induced-draft fans are regulated by combustion control system equipped with safety interlocks between the fans and coal feeders.

Effective removal of fly ash from the flue gas is imperative to prevent damage in manufacturing processes as well as to prevent fly ash nuisance in the territory surrounding the plant. Analysis of the performance, economic features and operating and maintenance problems attendant to equipment for this service prompted the choice of a scrubber consisting of a series of baffle plates over which a film of water passes, which is installed ahead of the induced-draft fans.

Scrubber drainage disposal was solved by the use of ebony impregnated transite pipe coated inside with asphalt. The joints in the scrubber drain lines are made by special "Dresser" couplings.

Boiler feed-water treatment is very important, inasmuch as the make-up requirements are approximately 40 to 75 per cent. The basic design of the water-treatment system was developed by the engineers in collaboration with S. T. Powell. All make-up water is taken from the

industrial supply of the Passaic Valley Water Commission after being treated in two gravity type zeolite softeners, each having a capacity between regenerations of 300,000 gal. The average rate of use per hour is approximately 12,000 gal. with a maximum rate for each unit of 36,000 gal. per hour. Soft water is discharged to two steel storage tanks, each having a capacity of 18,500 gal. Space for future installation of additional softening and treating equipment has been provided in the water treating plant.

Two steel tanks of 9,000 and 27,000 gal. capacity are also located in the basement of the water treating plant for service water and for ash sluicing and scrubber requirements. All cold-water tanks have been coated internally with Bitu-marine enamel and painted externally with nitrose.

Boiler feed water is delivered to the deaerators by two steam-driven pumps, after passing through a continuous blowdown heat exchanger where its temperature is raised 20 to 40 deg. The deaerator has sufficient capacity to heat 150,000 lb. of water per hour from 50 to 280 deg. F. when supplied with steam at 49.7 lb. per sq.in. absolute, and is guaranteed to deliver deaerated water to the boiler feed water system with 0 c.c. of oxygen per liter.

Manual feeding of water on one side of the boiler and automatic feeding on the other is provided. The differential pressure drop across the regulator is used to actuate the valve control diaphragms on the turbine driven 200 g.p.m. feed pumps for speed control and a chronometer valve in the motor feed pump discharge.

Extra heavy piping has been used throughout the plant, with Van Stone flanged joints in all high pressure steam and boiler feed water lines. With the exception of high pressure steam and boiler feed piping, wherever economically advisable pipe lines have been welded eliminating joints. Use of "creased" bends or fittings to save space, and corrugated pipe and bends or expansion joints in the exhaust lines for expansion purposes has been followed where economically justified.

(Continued on page 574)

EQUIPMENT DATA, FORSTMANN WOOLEN CO

Passaic Power Plant

Boiler and Auxiliaries

Boilers, 3-bent-tube four-drum water tube, 250 lb. pressure, 4,590 sq.ft. heating surface; water walls front, rear and side 1,875 sq.ft. heating surface; water-tube sloping front and rear floor 512 sq.ft. surface; 60,000 lb. steam per hour rated capacity, 3,150 cu.ft. furnace volume.....Riley Stoker Corp.
Superheaters, one per boiler, convection type 230 sq.ft. heating surface, 506 deg. F. steam temperature .....Riley Stoker Corp.
Air preheaters, 3-single-pass, vertical tubular 5,660 sq.ft. heating surface, 358 deg. F. air temperature .....Riley Stoker Corp.
Safety valves .....Crosby Steam Gage & Valve Co.
Blowoff valves .....Yarnall-Waring Co.
Soot blowers .....Diamond Power Specialty Corp.
Water columns .....Stets Co.
Boiler feed water regulators, one per boiler.....Stets Co.
Boiler non-return valves.....Edward Valve & Mfg. Co.

Fuel Handling and Burning Equipment

Track hopper and belt conveyors, 50 ton per hr. Stephens-Adamson Mfg. Co.
Ring roll type coal crusher.....American Pulverizer Co.
Coal bunker and spouts 400 ton storage Stephens-Adamson Mfg. Co.
Coal automatic weigh scales.....Richardson Scale Co.
Coal feeders, one per boiler.....Riley Stoker Corp.
Coal pulverizers, 3-Unit type, 5,000 lb. per hr., 75 hp., 1,150 r.p.m. General Electric turbine...Riley Stoker Corp.
Pulverized coal burners, flare type.....Riley Stoker Corp.
Oil burners, mechanical atomizing type .....Engineer Co.
Oil storage tank, 10,000 gal. .....Quaker City Iron Works
Oil pump and heater unit, steam and motor driven...Engineer Co.
Ash hoppers, with hydraulic nozzles .....Allen-Sherman Hoff Co.
Hydraulic Ash-Handling System .....Allen-Sherman Hoff Co.
Soot removal vacuum transport system, hydraulic ejector .....Allen-Sherman Hoff Co.
Forced draft fans, 3-horizontal double inlet, 20,000 c.f.m. at 7.6 in. static head, 45 hp., 1655 r.p.m., General Electric turbine .....Green Fuel Economizer Co.
Induced draft fan, 3-horizontal double inlet, 36,200 c.f.m. at 8.8 in. static head, 100 hp., 1060 r.p.m., General Electric turbine ..Green Fuel Economizer Co.
Flue gas scrubbers, three, direct contact water washing type, four sections each.....Riley Stoker Corp.
Stacks, 3-steel, 80 ft. high, 6 ft. diameter.....Riley Stoker Corp.
Steel plate air ducts .....Riley Stoker Corp.

Feed Water Equipment

Softeners, two zeolite, each 24,000 g.p.h. average, ...Hungerford & Terry, Inc.
Flow controllers and recorders .....International Filter Co.
Sodium sulphate feeding equipment..American Water Softener Co.
Deaerator, 1-direct-contact heating and storage type, 150,000 lb. per hr., 5,000 gal. storage.....Elliott Co.

Turbines, Condensers and Pumps

One, 1,250-kw., 3,600-r.p.m., condensing turbine with automatic extraction at 35 lb. per sq.in., 550-volt, generator, direct connected exciter and surface type air cooler .....General Electric Co.
One 300-kw. 5,054/1,200-r.p.m. geared condensing turbine, 550-volt, generator and direct connected exciter .....General Electric Co.
One relocated 750-kw., 3,600 r.p.m., condensing turbine, 550-volt generator and surface type air cooler .....Westinghouse Electric & Mfg. Co.
Condensers for 1,250- and 750-kw. units, two-pass horizontal 800 sq.ft. surface each, external air coolers, steam jet air removal, inter and after condensers, each unit with two 63 g.p.m., condensate pumps .....Ingersoll-Rand Co.
Condensers for 300-kw. unit, two-pass horizontal "Navy" type, 338 sq.ft. surface, internal air cooler, steam jet air removal, inter and after condensers, with two 23 g.p.m., condensate pumps .....Ingersoll-Rand Co.
Circulating water pumps, two 1,250 g.p.m., 1,750 r.p.m. 25 hp. 550-volt, motor drive .....Ingersoll-Rand Co.
Turbine expansion joints .....Griscom-Russell Co.
Boiler feed pumps, three 200 g.p.m. 3,400 r.p.m., 3 stage 350 lb., two with 80 hp. turbines, one with 75 hp. induction motor and Ruggles Klingemann excess pressure discharge control valve..Ingersoll-Rand Co.
Raw water pumps, 1-400 g.p.m., ...Warren Steam Pump Co., Inc.
Deaerator feed pumps, 2-350 g.p.m...Warren Steam Pump Co., Inc.
Ash sluicing pump, 1-1,000 g.p.m...Warren Steam Pump Co., Inc.
Back wash pump, 1-900 g.p.m. ....Warren Steam Pump Co., Inc.
Drip pumps, 2-50 g.p.m. .....Ingersoll-Rand Co.
Oil transfer pump, 1-75 g.p.m. .....Viking Pump Co.
Sodium sulphate pump, 2-5 g.p.m. .....Westco Pump Corp.

Instruments

Boiler meters, flow meters, level indicators .....Bailey Meter Co.
CO and CO_2 recorders and indicators ....C. J. Tagliabue Mfg. Co.
Multipoint temperature recorders .....Leeds & Northrup Co.
Draft gages, recording temperature and pressure gages .....Bailey Meter Co.
Indicating pressure gages .....Crosby Steam Gage & Valve Co.
Indicating thermometers .....C. J. Tagliabue Mfg. Co.
Mercury column vacuum gages .....C. J. Tagliabue Mfg. Co.

Pipe, Fittings and Valves

High-pressure steam pipe, boiler room .....M. W. Kellogg Co.
High-pressure steam pipe, turbine room..... Midwest Piping & Supply Co., Inc.
Cast steel, cast iron and bronze valves.....Wm. Powell Co.
Forged steel valves.....Consolidated Ashcroft Hancock Co., Inc.
Forged steel check valves .....Edward Valve & Mfg. Co.
Reducing valves .....Ruggles-Klingemann Mfg. Co.
Relief valves .....Atwood & Morrill Co. Cochrane Corp.
Extraction non return valve .....Schutte Koerting Co.
Expansion joints .....Croll-Reynolds Engineering Co.
Traps .....Armstrong Machine Works
Valve control .....Cutler-Hammer, Inc.

Miscellaneous

Combustion control, hand or automatic regulation of forced and induced draft fans, dampers, and coal feeders with interlocks and safety devices..Smoot Eng. Corp.
Turbine room crane, 15 ton one motor .....Whiting Corp.
Turbine oil purification equipment.....De Laval Separator Co.
Dual drive exciter, 30-kw., 1,800 r.p.m. 35-lb. back-pressure turbine; 50-hp., 550-volt, motor and 30-kw. 125-volt generator .....General Electric Co.
Relocated exciter, 50-hp., 850-r.p.m., 550-volt, motor, 30-kw. 125-volt generator Westinghouse Electric & Mfg. Co.
Vacuum cleaning system .....Spencer Turbine Co.
Tanks .....Pottstown Sotter Tank Works, Inc.

Electrical Equipment

Heat insulation .....H. W. Porter Co.
Process Water Heaters .....Cochrane Corp.
Continuous blowdown flash tank and heat exchanger .....Cochrane Corp.
Generator air cooler ducts .....Connery & Co., Inc.

POWER DECREASED 2 PER CENT

COAL REDUCED 15 PER CENT

In Hotel St. George, Brooklyn, N. Y., a more economical use of exhaust steam and improvements in power-plant operation saved 2,093 tons of coal in one year's operation

BECAUSE of large low-pressure steam requirements, a modern hotel offers opportunities for low-cost power generation not common in other classes of buildings. An outstanding example of how power and low-pressure steam loads may be combined in hotels is found in the St. George. This hotel occupies one city block, is 31 stories high, and has 2,632 rooms, making it one of the world's largest hotels. It has accommodations for 3,500 room guests, a large part of whom are resident, and has banquet-hall, dining-room and restaurant facilities to seat 9,000 guests. It houses one of the world's largest indoor swimming pools. To provide for these and many other services requires power and steam in large quantities.

The power generating plant consists of two 500-kw., and one 400-kw. corliss-engine driven, 3-wire, 120- and 240-volt, direct-current units and one 500-kw. turbine-driven generator of the same type. The latter is a standby unit in summer and provides additional capacity for winter load. A motor-generator set, consisting of a 100-hp. direct-current motor and a 75-kva., 140-volt, 3-phase alternating-current generator supplies power to electric signs and the swimming-pool sun lamps.

Four 4,500-sq.ft. water-tube boilers supply steam at 160-lb. gage. No superheaters are installed in the boiler, but the flue gas in the last pass is carried around the steam drum and adds sufficient heat to provide dry steam. Two boilers can supply the load at all times. They are fired by chain-grate stokers, and operate over a range of from about 100 to over 200 per cent rating, sufficient to accommodate variation between summer and winter loads.

The stokers operate on natural draft, produced by a stack 240 ft. high, and 50 sq. ft. in cross section. Draft is considerably in excess of that needed to operate two boilers at maximum rating. A bypass damper has been installed in the base of the stack, which when open allows air to pass directly from the boiler room up the stack. This improves boiler-room ventilation and relieves the uptake dampers of part of draft regulation. All dampers and stokers are controlled automatically.

A high-grade bituminous coal, having a heating value of about 14,000 B.t.u. is used. It is purchased under fairly strict specifications and delivered by trucks to the bunker, from which it flows by gravity to a belt conveyor dumping into an automatic weigh-scale hopper. After weighing, the coal is dumped onto a conveyor that runs above the firing aisle and which can dump into any stoker hopper.

CHIEF ENGINEER'S DAILY RECORD

	COAL				KILOWATT-HOURS		Rate of Evaporation	
Jan.	1932	1933	Increase	Decrease	1932	1933	1932	1933
1								
2								
31								
Remarks								

Fig. 1—Chief engineer's daily record form

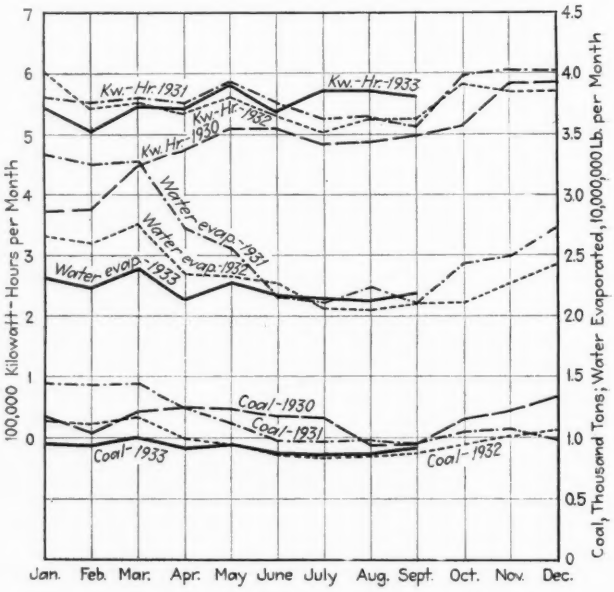


Fig. 2—Curves of power generated, coal burned and water evaporated

In general a record is not taken of the coal burned by each boiler, but of that used by the two. Should an unaccounted-for loss of efficiency occur, the coal can be weighed to each boiler and its operation checked. The coal bunker has been carefully calibrated so that weight of coal delivered to the bunker can be checked against the truck loads. It is possible to maintain a fairly close check between the weight of coal delivered by truck and that burned on the stokers.

Feedwater is metered by a recording and integrating flowmeter and its readings used as a record of steam produced. Each boiler is equipped with draft gages, a recording thermometer in the last pass and a CO_2 indicator and recorder. In addition to the gages on each boiler there is a recording feedwater thermometer, a steam-pressure-recording gage, a back-pressure recorder on the exhaust line and a recording thermometer connected into the exhaust line just outside the at-

mospheric relief valve. This thermometer shows when steam is passing this valve. Another recorder shows outside temperature.

In the chief engineer's office is a gage board on which are mounted indicating and recording gages for boiler pressure and, for back pressure on the engines, a recording thermometer connected outside the atmospheric relief valve to show when exhaust steam is being lost, four recording thermometers, one connected into the uptake of each boiler to obtain flue-gas temperature, a feed-water temperature recorder and a recording thermometer to obtain outside temperature. These meters give the chief engineer the information necessary to keep the plant under close supervision.

In the 140-ton refrigerating plant are three absorption-type machines operating on exhaust steam. One 50-ton unit is used on ice boxes and for making ice, about 5 tons of ice per day being required. One 50-ton unit cools the air to the dining rooms and coffee shops and a 40-ton unit air conditions the fountain room. Other services requiring large quantities of exhaust steam are water heating, building heating and the laundry.

The chief elements of power load are 21 electric elevators, which represent a connected load of 452 kw.; 73 ventilating fans with a combined motor load of 450 kw., and motors for pumping and other purposes. When the swimming pool is in service 875 g.p.m. of water is kept flowing through it continuously. This water, pumped from two wells over 100 ft. deep, beneath the hotel, has about one-half the salt content of sea water, and has a temperature of 52 deg. F. This water is filtered, sterilized with ultraviolet light and heated to a temperature of 76 deg. before going to the pool. Power for lighting represents one of the largest loads.

There is also an incinerator in which all the refuse from the hotel is burned. This requires about 240 tons of coal a year.

The plant has a normal rating of 1,900 kw. which is reached at peak load. Because of liberal design of both generators and prime movers, they have sufficient capacity to take care of 25 per cent overload without distress. The fact that the plant is operated under full-load conditions without reserve capacity and gives 100 per cent service, clearly indicates that its operation is of a high order. Inspection and repair work is so scheduled that, when the fall and winter heating and power loads begin, every part of the plant is in first-class condition.

Over 6.5-million kw.-hr. are generated per year, which makes the plant's annual load factor about 40 per cent. In 1931, there was generated 6,742,100 kw.-hr., 13,904 tons of coal burned and 315,845,200 lb. of water evaporated. Corresponding figures for 1932 were 6,593,000 kw.-hr., 11,811 tons of coal and 280,684,800 lb. of water evaporated. The average evaporation for these two years was 10.14 and 10.70 lb. of water per pound of coal and the boiler and furnace efficiency of 73.2 and 77.2 per cent respectively.

The curves, Fig. 2, show the kilowatt-hours generated, the water evaporated, and coal burned for the years 1930 to 1933 inclusive, with the exception of the water for 1930. That year was the first full year that the power plant operated after the hotel additions were completed and the water meter was not installed at the beginning of the year. The curves are interesting, particularly for the winter months, as they show that during these months the greatest saving has been made by reducing demands for steam. For January, 1931, steam requirements were 33,296,000 lb., while in January 1932, the steam dropped to 23,216,800 lb., a decrease of over 10,000,000 lb. The curve for 1933

NO._____

HOTEL ST. GEORGE ENGINEER'S MONTHLY STATISTICS

Date	LBS. COAL CONSUMED			COAL RECEIVED		K. W. GENERATED			BOILERS in USE		Evap. Per lb. Coal		TOTAL EVAPORATION	
	193__	193__	Difference	Tons	Lbs.	193__	193__	Difference	193__	193__	193__	193__	193__	193__

NO._____

MONTH OF_____ 193__

CUBIC FEET OF WATER USED					TOTAL		GAS CONSUMED					Average Temp. Outside
Meter 86	Meter 85	4"	6"	8"	193__	193__	Meter 1	Meter 2	TOTAL			

Date_____

HOTEL ST. GEORGE
DAILY POWER-PLANT REPORT

Pints of Oil taken from New Eng. Room to Old Eng. Room

ENGINE RUNNING RECORD

Watch	ENGINE STARTED UP No.1 A.M.	P.M.	No.2 A.M.	P.M.	No.3 A.M.	P.M.	No.4 A.M.	P.M.	ENGINE SHUT DOWN No.1 A.M.	P.M.	No.2 A.M.	P.M.	No.3 A.M.	P.M.	No.4 A.M.	P.M.	Total Eng. Run per 24 hr. No.1	No.2	No.3	No.4	Air Comp.	Engine	Cyl.
12-8																							
8-4																							
4-12																							

OIL RECORD — ENGINE REPAIRS AND REMARKS

Watch	OIL CHANGED, GALLONS No.1 ENG.	CYL.	No.2 ENG.	CYL.	No.3 ENG.	CYL.	No.4 ENG.	CYL.	OIL ADDED, GALLONS No.1 ENG.	CYL.	No.2 ENG.	CYL.	No.3 ENG.	CYL.	No.4 ENG.	CYL.	Engine No.1	Engine No.2
12-8																		
8-4																		
4-12																		

OIL PUT IN LARGE GEAR CASE, PINTS — OIL PUT IN SMALL GEAR CASE, PINTS — ENGINE REPAIRS AND REMARKS

Watch	No.3 Stoker R	L	No.4 Stoker R	L	No.5 Stoker R	L	No.6 Stoker R	L	No.3 Stoker R	L	No.4 Stoker R	L	No.5 Stoker R	L	No.6 Stoker R	L	Engine No.3	Engine No.4
12-8																		
8-4																		
4-12																		

STOKER REPAIRS AND REMARKS — ON WATCH

Watch	No.3 Stoker R	L	No.4 Stoker R	L	No.5 Stoker R	L	No.6 Stoker R	L	Engineers	Fireman	Oilers
12-8											
8-4											
4-12											

FEED WATER — FLUE-GAS ANALYSIS

Watch	METER Former Reading	Present Reading	Total Lb. per Watch	Evap. per lb. Coal per watch	Evap. per 24 hr.	Temp. Deg. Per Watch	Per 24 hr.	CO_2 per Watch	Av. 24 hr.	Flue Draught-In. Per Watch	Per 24 hr.
12-8											
8-4											
4-12											

COAL REPORT — KW.-HR. GENERATED — WATER METER

Watch	Coal Burned per Watch	Amount Ashes Buckets	Lb.	Boilers Used	KW.-HR. GENERATED Former Reading	Present Reading	Total per Watch	Meter	WATER METER Former Reading	Present Reading	Total per 24 hr.
12-8								No.86			
8-4								No.85			
4-12								4-In.			
	Coal Burned per 24 hr.	Ashes per 24 hr.					Kw.-Hr. Gen. per 24 hr.				

GAS-METER READINGS — REMARKS

Meter	Former Reading	Present Reading	Total per 24 hr.	
No.1				
No.2				

Figs. 3 and 4 (Top)—Facing pages in plant performance record book
Fig. 5 (Bottom)—Plant daily log sheet

shows that winter steam requirements are not far from the summer load. In other words, little live steam is required for heating during the winter months. This change along with improvements in boiler operation has been reflected in the coal pile. In 1932, for steam generation, the plant burned 2,093 tons less coal that in 1931, a saving of 15 per cent. During this period the steam consumption was reduced 11 per cent. For 1933, a further reduction is shown both for coal and steam.

In this plant, because of absorption refrigerating load, there is not the wide variation in exhaust-steam demands as where compression refrigeration is used. During the winter months when the heating load is heavy, refrigerating requirements are light. In summer when there is little or no heating load the refrigerating demands are heavy. The many kinds of services permit skillful manipulation of the refrigeration and other loads to obtain maximum use of exhaust steam and keep down live-steam requirements.

For example, after the evening meal hours the refrigerating load is light. At that time the ice is pulled and the cans filled with water. By the next morning the days' ice harvest has been fairly well frozen before the air-conditioning and ice-box refrigerating demands begin. In cold weather little refrigeration is required for air-conditioning. The reduction in exhaust steam from that service is available for heating where the requirements

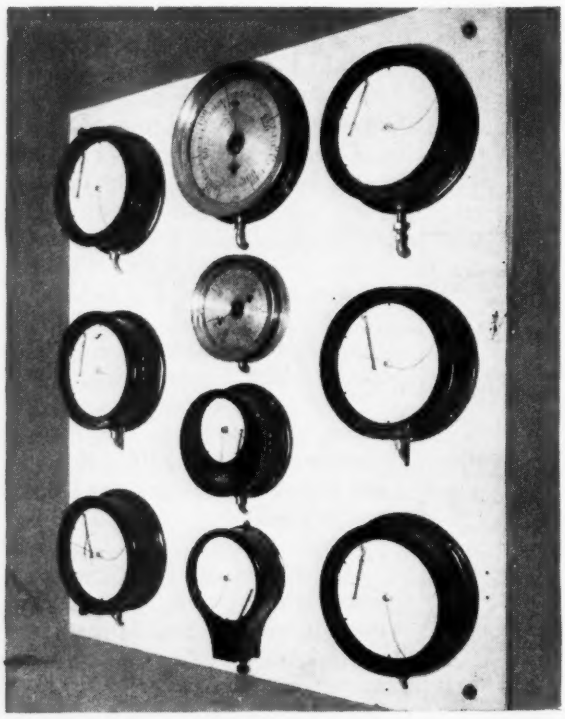


Fig. 6—Meter board in chief engineer's office

are heavy, thus keeping the use of live steam to a minimum.

The plant is now operated under practically test conditions. Each operating shift is held accountable for results obtained on that shift. When one shift relieves another the meters are read and a report made to John A. Sether, chief engineer, under whose supervision the plant is operated. This report includes the coal-scale reading at the beginning and at the end of the shift, the pounds of coal burned, the water-meter readings at the beginning and at the end of the shift and the pounds of water evaporated, the pounds of water evaporated per pound of coal and the kilowatt-hours generated. Each report is agreed to by both the incoming and outgoing shift engineers.

By this method it is possible to place the responsibility for plant performance directly on the shift in charge and, if results are below standard, to immediately correct the fault. The chief engineer, however, does not necessarily have to see the shift report to know how the plant is performing, for the recording meters in his office give a close check and if anything abnormal develops it is looked after without delay.

At the end of each 24-hr. operation a report, similar to the shift report is made to the chief engineer. From this a daily record sheet is compiled on the form, Fig. 1. Before the beginning of each month the previous year's figures are filled in on the sheet by the record clerk, then each day, when the 24-hr. report is received, the daily record for that date is completed. By this means the chief engineer has available on his desk at all times a day-to-day comparison of the plant's operation for the present and the previous year.

A daily log sheet, Fig. 5, is also maintained. From this sheet a record book is compiled. This record, Figs. 3 and 4, comprises two facing pages in the book and gives data necessary to compare daily operation of the present with the previous year. At the bottom of these sheets a comparison of monthly operations is made. From this record a monthly report is made to the hotel manager and to M. Messner, Chief Engineer, Bing & Bing, operators of the hotel. These reports are brief, giving the essential information for a comparison of the plant's performance with the same month in the previous year.

A detailed yearly report is compiled from the monthly reports. This compares by months the two previous years' operation of the plant and also gives a detailed comparison of the year's operation. This report also includes a comparison of costs. One of these reports goes to the hotel manager and another to Mr. Messner.

This strict supervision and close check on the plant's operation has resulted each year in improved performance over the previous year.

Cracking of Cylinder Liner Stopped by Drilling Holes

By J. Cassidy

A CRACKED cylinder liner does not occur very often and is generally the result of applying too much pressure to the liner when it is being forced into the cylinder of a gas or oil engine. After the engine is in service for a while, cracks begin to develop around the end of the liner where it is held by the fitting strip. Conditions are aggravated by the high temperature of the gases and effects of the cooling water.

No permanent repair to the liner is possible, but its life can be prolonged by drilling small holes at the extremities of the larger cracks. In one horizontal engine with a 26-in. cylinder a great many microscopic cracks could be seen in the cylinder liner. In this case 36 small holes were drilled at the extreme end of the larger cracks, which varied from 1 to 3 in. long. After this was done, the engine operated for two or three years, the liner being renewed when the plant was sold several years after the first cracks appeared in the liner.

By W. R. KITZMILLER
Waynesboro, Pa.

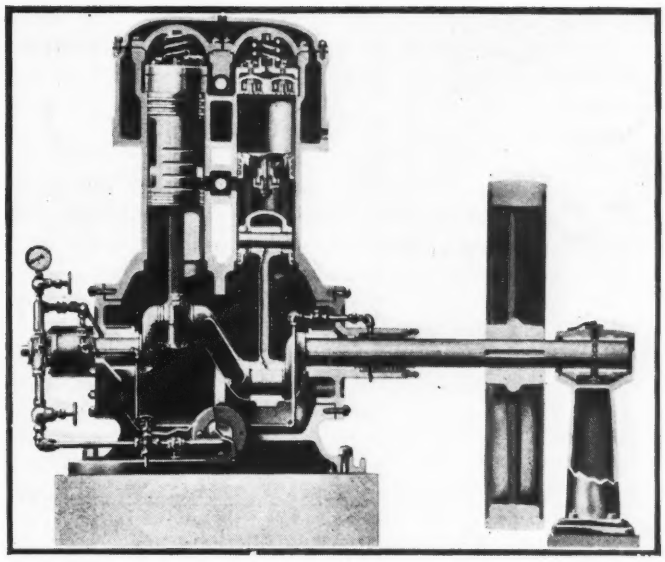


Fig. 1. Cross-section of vertical compressor

How to Select AMMONIA COMPRESSORS

Many types of ammonia compressors are available and each has a particular field for which it is best suited. In this article the author discusses vertical, horizontal, rotary, compound and dual effect compressors and their applications.

AMMONIA compressors should provide the greatest reliability and longest possible useful life, in spite of the severe service under which they may operate. This is true of the smallest compressor to the largest, although the types of design will vary according to size. It is the larger compressor designs that interest most refrigerating engineers, since these are the backbone of ice manufacture, storage, process work, refineries, air conditioning, and other substantial refrigerating projects.

The vertical ammonia compressor is the type of machine selected for most refrigerating projects. A cross-section of such a unit is shown in Fig. 1, and from it the action of the valves, pistons and crankshafts is obvious, but the lubricating system is not easily seen. A gear oil pump is generally mounted on the outer housing of the crankshaft, where the pump is driven by a pin engaging with the crankshaft. Oil is drawn from the bottom of the crank case through a screen filter and pumped through piping to a hole in the crankshaft, thus lubricating main bearings and with oil pressure of from 15 to 25 lb. above suction pressure. The spring release valve allows the excess oil to flow into a line connected with the stuffing box. This line is fitted with an overflow connection permitting a seal on the stuffing box without building up pressure.

In addition to good lubrication the vertical compressor should have a full-sized bypass, quiet valves with ample area, piston speed not exceeding 600 ft. per min., proper size bearings, pins and shafts. It is difficult to set a standard for this equipment, since material and design will be the deciding factors. Suction, strainer and oil filters should be a part of every well designed compressor.

Packing is also very important, and sometimes the best will run hot upon starting. This may be due to improper lubrication or fit. If due to hugging the shaft too closely, lengthen the packing slightly by hammering over a cylindrical form on the back edge next to the outside of the gland.

There are special requirements to be met in many application requiring changes to the standard compressor. For example, the most desirable feature to be applied to many compressors is a scheme for varying the compressor capacity to meet varying loads when the compressor is driven by a constant-speed prime mover.

Fig. 2 illustrates a method of fitting a compressor to the load by capacity control pockets. It is possible to operate such a machine at 100 per cent capacity, or reduce it at will in any desired number of steps, to approximately 50 per cent capacity, thereby saving the power that would be consumed in operating at a lower suction pressure. There are cases where the recently designed variable-speed induction motor will fit into reduced compressor capacity, although the number of steps required to met some loads will probably result in an expensive motor.

In many installations two different suction pressures are required. This is especially true in ice plants where liquid and water is cooled at a higher pressure. For such

Brake horsepower per ton of refrigeration

Suction Pressure, lb. ga.	11.7" vac.	5.4" vac.	0	5	10	20	30
Vertical compressors slow speed	...	...	2.62	2.18	1.87	1.49	1.24
Horizontal straight compression	...	3.44	2.90	2.35	2.03	1.59	1.32
Vertical compressor high speed	...	...	2.99	2.43	2.11	1.68	1.40
Horizontal compound compression	3.39	2.76	2.45	2.08	1.80	...	...
Horizontal compound liquid cooling	2.91	2.47	2.23	1.97	1.74	...	...

service the dual-effect compressor[1] is best suited. This compressor draws in low-pressure gas until the end of the stroke is reached, when the high-pressure gas rushes in.

The use of double suction on a standard compressor allows two pressure operations by confining each pressure to a particular cylinder. This generally works well in larger plants where one machine is often equipped in this manner to be used on either one or two suction pressures. The double-suction compressor can be furnished with capacity control pockets, which is also possible in dual-effect machines. They allow reduction of the low-pressure load without affecting the high suction pressure load.

Horizontal compressors meet low-pressure requirements better than the vertical machines, as the pistons and rods operate through a stuffing box rather than in the open crank case, and thus prevent pumping oil when working below atmospheric pressure. An exception is the high-speed vertical compressor equipped with a forced feed lubrication which eliminates high oil level in the crank case. However, an oil film is always present in the vertical crank case, and this may be pumped into the condenser on vacuum operation.

This type compressor generally makes a better compound compression installation, although the vertical compressors have been arranged in duplex with each machine proportioned for compound operation. Modifications common to the vertical compressor, such as dual effect, double suction and capacity control, can also be applied to the horizontal compressor. Fig. 3 illustrates a horizontal unit driven by a synchronous motor and equipped with capacity control pockets.

Use of compound compressors has gradually increased since low-temperature refrigeration and process work have demanded high efficiency at low pressure. In these units the low-pressure piston draws gas from the evaporator and discharges to a water-cooled intercooler. From this point the high-pressure system draws in the gas and discharges to the condenser.

The intercooler should always be carefully and adequately designed, since it is the heat absorbed by the water here that saves power. Occasionally liquid cooling is performed at this intermediate pressure, and then the gas is delivered to the high-pressure cylinder in a saturated condition. The liquid cooling will also permit several percent more saving in power.

It is important to have the cylinders of the compound units carefully proportioned. Intercooler surface should be ample and the valve areas as large as possible. The two last requirements are equally important, as the first saves power and the latter cuts down any pressure drop. Compound compressors may operate at 12 to 15-in. vacuum, so a well designed stuffing box is imperative. In operating at pressures below this it is always well to consider booster compression with liquid cooling.

For vacuum operations a booster compressor is often used ahead of the compound compressor. Especially in oil refining where very low temperatures are required, the booster compressor is efficiently employed to raise the low-pressure gas up to a pressure suitable for economic compound or straight compression.

Booster compressors are designed similar to the low pressure cylinder of the compound machine. Stuffing box design is of utmost importance. The inner packing must make a good seal between the cylinder and the outer packing. The outside packing seals against pressure which is admitted between the two packings. In case the inner packing leaks slightly it can only draw in ammonia, which is under moderate pressure between it and the atmosphere.

Fig. 4 illustrates a booster compressor of the rotary type. This compressor will serve efficiently for low-temperature refrigeration. It is especially suited to operate at a 15 to 20 in. vacuum, pumping into a vertical

[1] A detailed description of the dual effect machine appeared in the Oct. 13, 1931, issue of *Power*.

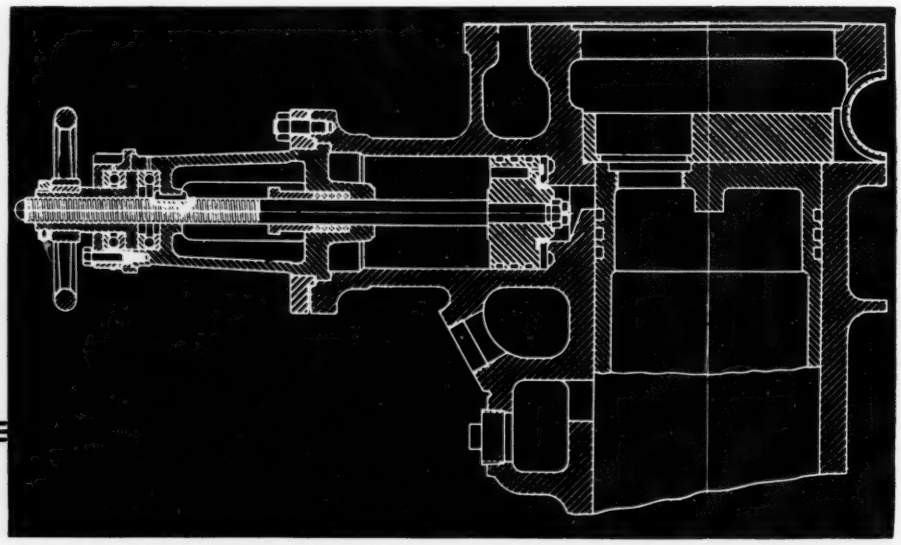


Fig. 2. Clearance pocket for capacity control applied to enclosed type machine

Fig. 4. Rotary booster compressor with sliding vanes

(Next page)

compressor suction at about 20 lb. pressure. This permits low-temperature operation as required for ice cream, frozen foods, etc., and when used as a booster in connection with a vertical compression will permit a substantial saving in power over the straight compression machine.

This multi-cellular sliding vane-type compressor operates at comparatively high speeds, allowing direct connected motors and eliminating speed reduction drives. An automatic seal ring in place of the usual stuffing box eliminates air from the system and roller bearings carry the rotating parts. Flow of gas is constant, without pulsating effect. The space required is small and foundations need not be designed for heavy loads.

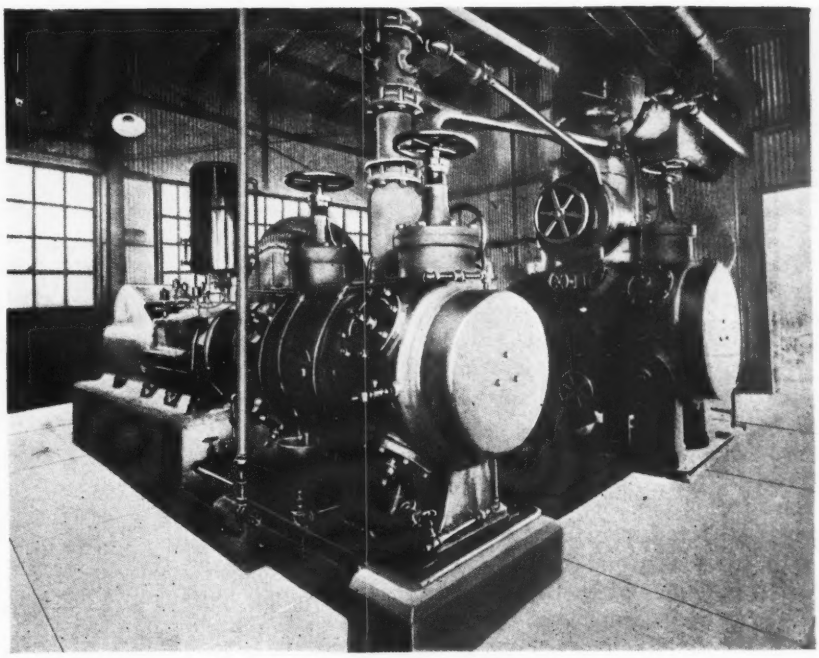
If operating on a vacuum, straight compression, it will be possible to increase capacity considerably over the increased horsepower by installing a booster compressor head of the straight compression machine. On fair sized rooms or loads a booster on each unit will permit flexibility for either hand or automatic operation.

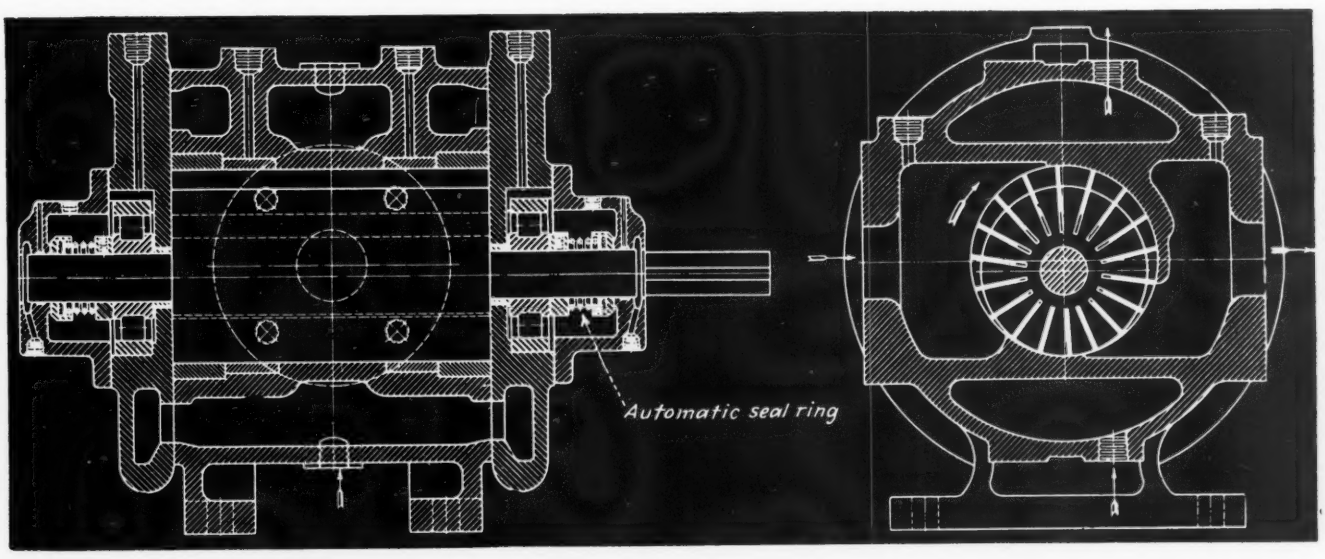
General operating performance of various compressors is hard to forecast, since variations in design and size will give different results. The table shows a fair average of brake-horsepower per ton of refrigeration for low- and high-speed vertical, medium speed horizontal, and compound compressors. Some of this data is theoretical, but attempts have been made to line it up with actual results for fair comparison.

It is seen from the table that the medium-speed horizontal compressor, 150 to 225 r.p.m., requires slightly less power per ton than the high-speed vertical compressor of 300 to 650 r.p.m. This is due in part to the gradual loss in efficiency from increased speed in the vertical compressor, even though the horizontal compressor does have higher frictional losses. The saving in power by liquid cooling in the intermediate stage of compound compression yields approximately 10 per cent increase in refrigeration per horsepower input.

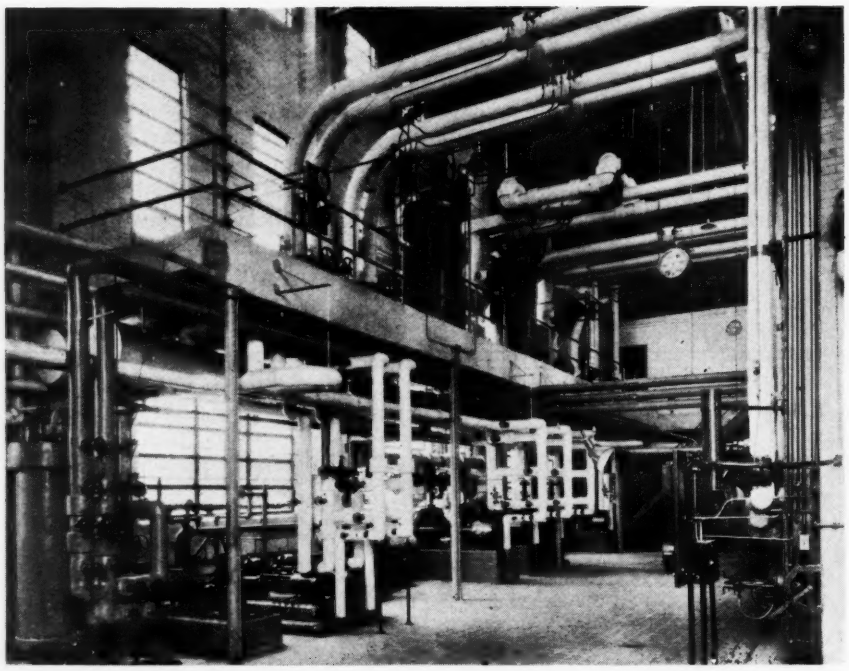
In selecting the compressor prime mover it is advisable to study operating costs thoroughly. Convenience alone cannot be considered in many plants now facing a profitless year, due to high power costs and curtailed production. Some localities have unusually high electric rates so oil engine-driven compression may be cheaper. Fuel oil consumption for oil engines will run from 0.4 lb. at full load to .5 lb. at half load per brake-horsepower-hour. In actual operation of the average ice plant, fuel consumption will vary between four and five gallons per ton of ice. The lubricating oil will average about 1/5 gallon per ton of ice.

Fig. 3. Horizontal compressor in an oil refinery





HEAT—POWER—REFRIGERATION



Fuel oil and feed-water pumps face the boilers, convenient to the operator

for the new

QUEENS GENERAL HOSPITAL

NEW YORK CITY

ALL power services, including electricity, refrigeration, building heat and hot and cold water for the new Queens General Hospital, recently completed by the City of New York, are supplied from a separate power plant and service building somewhat north of the main hospital building. Adjoining the new hospital, which has a present bed capacity of 500 and an ultimate capacity of 1,250, is the present Queens Hospital for contagious diseases, which will be supplied with electricity and heat from the new power plant. Other buildings of the new hospital are a nurses' home, staff building, employees' quarters and mortuary. In the service building group, in addition to the power plant, are laundry, garage and storage rooms.

The power plant is at the easterly end of the service building group and is constructed of red brick and in the same architectural style as the main hospital building. The boiler room operating floor is located about 6 ft. below grade, so has been carefully waterproofed. Air-cooled and well-insulated furnace bottoms have been provided under each boiler in order to protect this waterproofing.

Steam is generated in four Union Iron Works longitudinal-drum boilers of 3,800-sq.ft. heating surface, built for 200-lb. pressure and operated at 175 lb. Space has been provided for the installation of an additional future boiler. The boilers are set in a single firing aisle in groups of two, with a common dividing wall between. The settings are of solid firebrick with monolithic linings, and inclose furnaces of 1,713 cu.ft. designed for oil-firing. Three oil burners of the pressure-atomizing type have been provided for each boiler and designed to produce 200 per cent rating. The bottom boiler header is 12 ft. above the furnace floor.

Fuel oil is stored in three 10-ft. diameter, 42-ft. long oil-storage tanks located in a concrete pit outside the boiler room. Each tank is provided with steam coils to maintain the oil at proper temperature. Two 7 x 4½ x 10-in. duplex steam pumps, and one electric pump, are installed to deliver oil from the storage tank through oil feeders to the burners of each boiler. A small hand pump is provided with which oil can be supplied to the boiler for starting up the plant. The boilers operate on natural draft supplied by a single brick stack of 7 ft. 3 in. inside diameter and 170 ft. high.

Gage boards have been provided for each boiler and contain CO_2 meter, draft gage, pressure gage and indicating and recording flowmeter. In addition, each boiler is provided with a smoke indicator operated by a light shining through the boiler breeching and transmitted by mirrors to a location alongside the boiler gage board.

Steam at 175-lb. pressure is taken from each boiler through duplicate boiler leads and non-return valves to a double header which runs the length of the boiler room along the wall facing the boilers and just under a mezzanine floor. This header forms a loop in the engine room adjoining the boiler room.

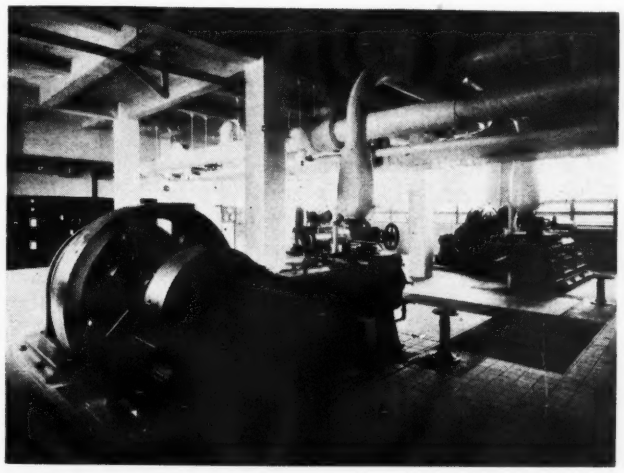
Under the mezzanine and directly in front of the boilers are located various pumps. These include the fuel pumps, three steam-driven feed pumps and air compressors. The feed pumps, which are duplex 10 x 7 x 12-in., take their suction from feed-water heaters located on the mezzanine directly above, and discharge the water through the feed-water level regulators to the boiler. The feed-water regulators and hand control valves are within easy reach of the fireman from the boiler-room floor. Each pump is provided with a steam-pressure regulator operated from the boiler feed pressure.

The two feed-water heaters receive exhaust steam from the engines, and are each capable of heating 45,000 lb. of feed water per hour from 70 to 212 deg. To the

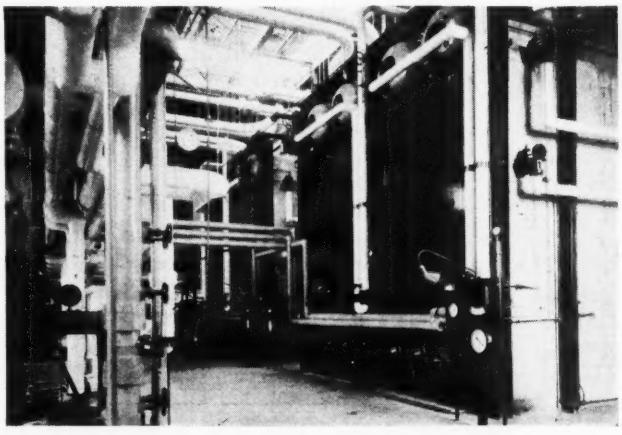
feed-water heaters are returned the condensate from the building heating system, low-pressure and high-pressure drips from the hot water and laundry water heaters, and the intermediate pressure drips from kitchen and laundry equipment. Make-up is filtered city water from the house tank on the main hospital building roof. No feed-water treatment is provided.

The engine room adjoins the boiler room and contains three engine-driven generating sets. Direct-current, 120-240-volt generators are direct-connected to Elliott four-valve engines, two of which are 250 kw. in caacity, and one 100 kw. The engines receive steam from a loop header which is valved so that either side of the header can be shut down without putting an engine out of operation. Exhaust is at 3 lb. back pressure through a 48-in. diameter 10-ft. long, muffler and separator located beneath the engine-room floor, thence to a 16-in. low-pressure exhaust line, one branch of which leaves the plant in a tunnel and supplies the heating systems in all of the hospital buildings. The other branch rises to supply domestic and laundry water heaters and the feed-water heaters.

In the aisle between boiler room and engine room are the domestic water pumps. Two of these are duplex 12 x 8 x 12-in. reciprocating pumps; the third is an electric pump of 250 g.p.m. These pumps take their suction from a filtered water storage tank and deliver to a house tank on the roof of the main hospital building.



Present capacity of the generating equipment is 600 kw.



Steam for power and heat is supplied by four 3,800-sq.ft. boilers

All of the water used in the power plant and the hospital is filtered through five filters on a gallery above the boiler-room mezzanine floor. An electric-driven fire pump of 750 g.p.m. also takes suction from the filtered water storage tank, and is located alongside the house pumps.

Domestic hot-water heaters and laundry water heaters are also on the same gallery as the water filters. These receive water from the house tank. The two domestic water heaters are each capable of heating 3,000 gal. of water per hour from 60 to 180 deg., and have a storage capacity of 2,500 gal. The laundry heater is of the instantaneous type and will heat 5,000 gal. of water per hour. Two hot-water circulating pumps of 50 g.p.m. each are located in front of the water heaters and circulate the hot water through the various hospital buildings.

On the mezzanine floor are two reducing valve stations. One of these supplies make-up low-pressure steam to the exhaust line, in case there is a deficiency in exhaust steam for feed- and hot-water heating. The other reducing valve supplies 60-lb. steam to the laundry. In addition to these reducing valves, there are reducing valve stations in each of the various hospital building basements that supply make-up steam to the low-pressure exhaust line in case of a deficiency in exhaust for building heating. There are also reducing valves for supplying 40-lb. steam for kitchen and sterilizing uses. These reducing valve stations are supplied through a 6-in. high-pressure steam main which parallels the exhaust main in the tunnel.

The tunnel, concrete waterproofed and about 2,000 ft. long, is constructed under all of the hospital buildings and carries in addition the cold domestic water supply, the hot domestic water supply, heating system return mains, brine piping, compressed air piping, drinking water supply and return, sprinkler system water and gas. The tunnel varies in height from 8 to 11 ft., and in width from about 7 to 10 ft.

All high-pressure steam piping is of extra-heavy steel. All pipe joints are welded, welded pipe fittings being used throughout.

Refrigerating equipment is located above the engine room and includes two 22-ton, motor-driven, CO_2 compressors. It supplies refrigeration for ice-making, hospital drinking water, food storage space in the service building and hospital kitchens and the mortuary. The three-stand, double-pipe, CO_2 condenser is twelve tubes high and is supplied with city water which is discharged to the sewer. Brine is cooled by bunker coils in the brine storage tank. The brine is circulated by electric-driven pumps, one of which circulates brine to the ice tank, the second circulating the brine to the drinking water coolers, storage refrigerators, mortuary, and other hospital uses. A third pump is provided as a spare.

The capacity of the ice-making equipment is 10,000 lb. per day in 250-lb. tanks.

All buildings are heated by two-pipe, up-feed, low-pressure systems with vacuum return. Each building has separate, duplex, motor-driven vacuum heating pumps returing all condensate to the feed-water heaters in the power plant through a common return line.

The total amount of direct radiator heating surface for the entire institution is 54,000 sq.ft. Practically all radiation is exposed cast iron of the narrow-tube type. All radiators are legless. They are controlled by a pneumatic system of temperature control.

In the surgical operating rooms, emergency and delivery rooms, emergency heating is provided to insure ample heat at all times. Steam from the surgical sterilizer piping system is supplied to convection radiators with manual control valves. Radiator cabinets are specially designed to permit sterilizing cabinets and radiators.

The ventilating system has fourteen multi-blade blowers having a total capacity of 83,000 c.f.m. Most of the ventilating equipment is in the main building for the supply and exhaust ventilation of the kitchen, public corridors, toilet rooms, diet kitchens, laboratories and operating rooms. Ventilation of the operating rooms is controlled by pushbuttons in each operating room. All supply air fans are equipped with automatic self-cleaning viscous oil filters.

Although construction work on the hospital and power plant is completed, the hospital has not yet been put into operation. It is expected that all exhaust steam from the engines will be used, even during the summer months, because of heavy demands by the laundry and hot-water service to the hospital. Space has been left in the engine room and boiler room for the addition of another engine and boiler to take care of future needs.

Information contained in this article was secured through the courtesy of John H. Gerken, Deputy Commissioner of Hospitals in New York City, and Syska & Hennessey, who did the engineering for the hospital.

Power-Driven Hoists Handle

McIndoes Dam Flashboards

FOUR units totaling 13,200 kva. make up the McIndoes hydro-electric plant of the New England Power Association system. Both pin- and stanchion-type flashboards are used, and their cost, as shown in the table, is derived from a comprehensive analysis of plant investment prepared by the engineering and accounting staffs of the system.

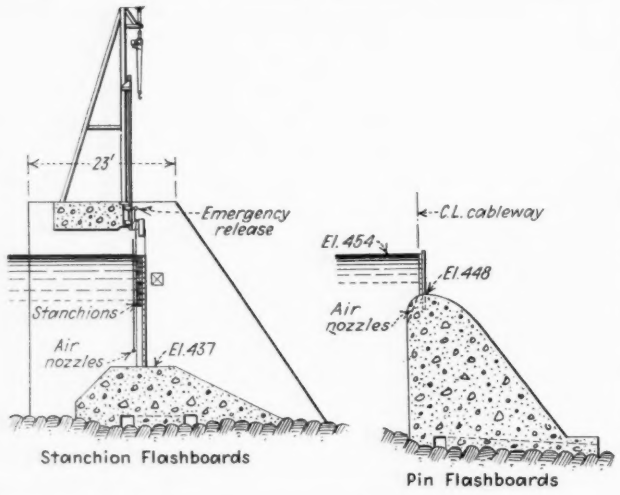
A 4-ton cableway is used to remove and replace the flashboards and pins on the pin-type section of the 300-ft. spillway, as shown. Flashboards are made up in 24 in. panels of 1-in. planks, using two 12-in. planks per panel. Three panels make up the 6-ft. height to which the boards are carried above the dam top. Cables on each panel make it easy to remove them with the traveler to a place of storage pending use after subsidence of high water. A section consists of three panels, pins and the cable attachment.

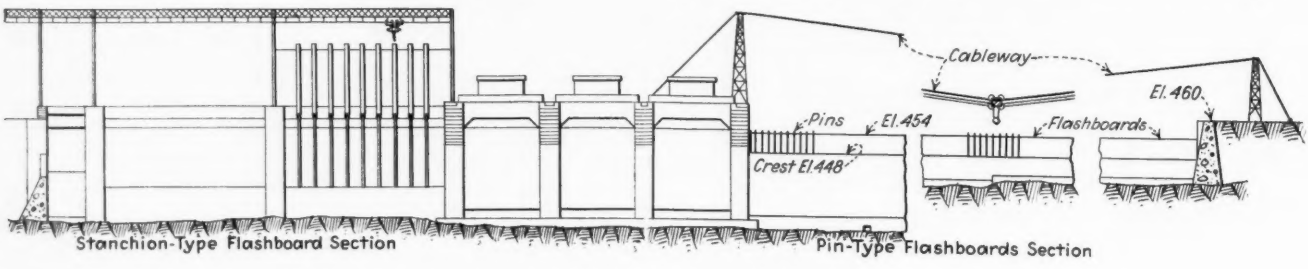
In hooking the cableway traveler into flashboard sections, the operator doing the work stands behind the flashboard on the downstream side of the dam, moving to another point before the section is removed. If water rises too rapidly to permit withdrawal of the boards and attached pins before it begins to flow over their tops, it is too late to save them by lifting them out of position with the cableway.

Two grades of pins are used, each serving half the spillway section. Half the crest is provided with 3-in. standard pipe spaced on 2-ft. centers, the other half with 3-in. extra-heavy pins. The standard pins are designed to fail (with resulting loss of the connected boards) if the water reaches a height of 23 in. above board tops; the extra-heavy pins when the water exceeds 33 in. above. Pins rest in sockets of 4-in. extra-heavy pipe set 30 in. into the dam crest.

There are 100 ft. of stanchion-type boards, 17 ft. high. The stanchions are 16-in. I-beams on 5-ft. centers supported by casting in the dam. The boards are 4-in. spruce, the top 90 in. being backed by 10x10-in. timber to resist ice pressure. These boards are placed between the webs of the I-beams after the fashion of a stop log installation, and are removed by hooking a hoist into an attached cable and lifting them out of place.

After the boards are removed, the stanchions can be lifted out of their sockets in the dam by this hoist, if desired; but this would not ordinarily be done unless ice threatened. In case the water rises too rapidly to permit hoisting of these flashboards, they can be released by striking trips at the tops of the stanchions, the oper-





Cost of Flashboards and Gates

Pin-Type Flashboards

Items	Cost	Unit Cost
Labor	$929	$0.52 per sq. ft.
Material		
Flashboard pin sockets, 500 pieces	761	
Flashboard pins, 480 pieces	1,127	
Lumber, 13,089 f.b.n. spruce	490	
Cable, 1,500 ft.	98	
Miscellaneous, including cable clips iron, nails, tools, etc.	158	
Angle iron, 2,160 lb.	72	
Total Material	2,706	$1.50 per sq. ft.
		$2.02 per sq. ft.
Total Cost	$3,636	or 0.27 per kva.

Stanchion-Type Flashboards

Labor	$2,005	$1.11 per sq. ft.
Structural steel monorail supports and stanchions, 75,300 lb.	1,464	
2-ton electric hoist	650	
22 needle beams with plates and channels	995	
18 needle beams sockets, slides, latches, trig	882	
Creosoted pine lumber, 660 ft. b.m.	70	
Lumber, 7,459 ft. b.m.	177	
Miscellaneous	724	
Total Material	4,962	$2.76 per sq. ft.
Total Cost	6,968	3.87 per sq. ft.
Less hoist properly charged to flashboard handling equipment	650	
		$3.85 per sq. ft.
Net Cost	$6,317	or 0.48 per kva.
Flashboard handling equipment, including 2-ton cableway of 321-ft. span (cableway and carriage, $3,800; labor, $1,013) and above $650 hoist; Miscl supplies, $1,479	$6,982	$0.53 per kva.
Spillway Flashboard structural steel (Cover cost and installation of towers and structural steel for the cableway provided for handling the pin-type flashboards)		
Labor	$443	
Material	939	
Total	$1,382	$0.104 per kva.
Skimmer Gate (One 12-ft. x 13-ft. gate, with hoist)		
Labor	$1,033	
Material (Gate, $2,116; Misc., $574; Hoist and motor, $1,915)	4,605	
Total	$5,638	$0.425 per kva.
Tainter Gates and Hoists (3 Structural steel gates, 24-ft. x 25-ft., each with 30-ton hoist)		
Labor	$5,215	$0.394 per kva.
Material (3 Gates, $16,1110 hoists, $12,490; Misc., $2,855)	31,456	$2.38 per kva.
Total	$36,671	$2.70 per kva.
Spillway Bridge Deck (Covers cost of bridge over skimmer gate, stanchion-type flashboards and in front of Tainter gates)		
Labor	$2,797	
Material	6,028	
Total	$8,825	$0.67 per kva.

ator working from a bridge which crosses over the skimmer gate and stanchion sections of the headworks. When released in this way, the boards and vertical I-beams are lost, since the latter rest in shallow sockets in the dam and are easily swept away if tripped at the top.

In addition to the two flashboard sections of the dam, which will pass a total of 40,000 cu.ft. per sec. during a flood, there are three Tainter gates 24 ft. wide by 25 ft. high which, with the skimmer gate (12x13 ft.), will pass 25,000 cu.ft.

The Tainter gates are of riveted steel, with non-parallel arms to prevent difficulties due to ice formation between the piers and the arms. Individual 30-ton, motor-driven, double-drum hoists operate these gates. The hoists are mounted on steel beams spanning the gate openings. A wooden sealing strip is used at the bottom of the gate, with rubber seals at the sides in contact with steel seal plates on the pier faces. Space is provided in the piers behind these plates for electric heaters to prevent freezing at the vertical joints. About 8 kw. per gate is sufficient for the severest weather.

The skimmer gate is made of steel plate, concrete-filled, and is lowered to allow trash and ice to pass over its top. It is operated by a 50-ton, motor-driven hoist.

PANAMA CANAL USES SUPERVISORY POWER-SYSTEM CONTROL

AN EXTENSIVE Westinghouse supervisory control system replacing manual operators and telephonic dispatching has improved the operation of the electrical system at Panama Canal, especially under emergency conditions. The entire power system is now controlled by two dispatchers, one at the Gatun hydro station and the other at Miraflores diesel-electric station. Concentration of control not only gives better system operation, but effects operating economies which, according to estimates, will liquidate the cost of the supervisory control equipment within three years. The supervisory control averages about 3,000 operations a month.

The Canal Zone requires an electric generating, transmission and distribution system comparable to a public utility system in an industrial area in the United States.

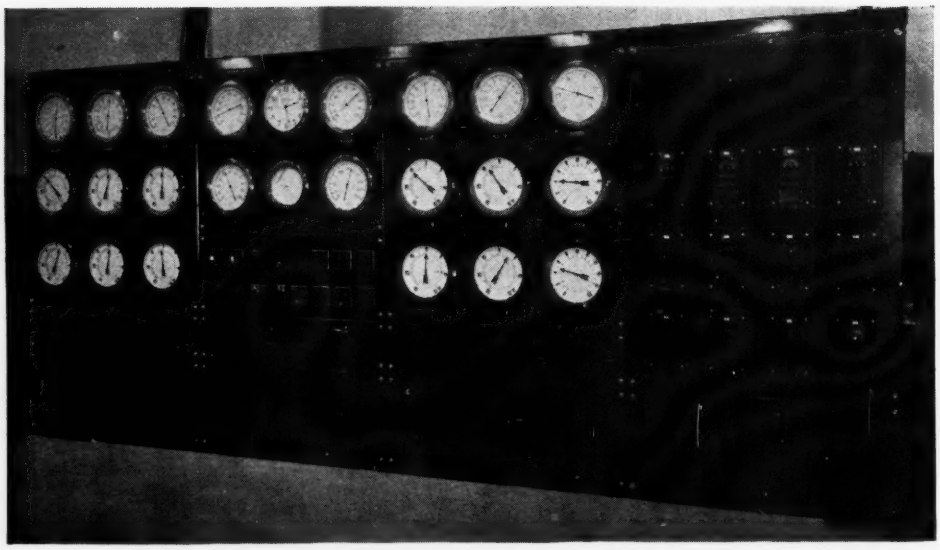
The main power supply is generated by a hydro-electric station of 13,500-kw. capacity, with provision for future extension to 22,000-kw. This station is at Gatun Dam and uses water from Gatun Lake. In addition, there is a diesel-electric generating station at Miraflores with three units totalling 7,500-kw. capacity, used for emergency standby and peak-load assistance to the hydro station. At Madden Dam there is now in the preliminary stages of construction a second hydro station which will have 16,000-kw. initial capacity.

Supervisory control differs from the usual remote power control schemes in that it operates over a few small wires similar to those used for telephone purposes, the currents used are of comparatively small magnitude, and it operates over far greater distances than is practical or economical with ordinary remote control. Supervisory control provides more prompt and accurate response to dispatcher's orders than could be obtained from manually operated substations. In addition, quick sectionalizing of faults and prompt restoration of service under emergency conditions is possible.

On account of the large amount of apparatus to be controlled at the Cristobal and Balboa substations, the synchronous visual type of supervisory control, using four telephone type line wires, was installed to control these two substations and the Summit switching station. The Gatun substation will be controlled by the Visicode type of supervisory control which will shortly be installed and will operate over two telephone type line wires. The supervisory system may be summarized as:

Dispatching point	Type of Supervisory Control	No. of Line Wires	Distance in Miles	Stations Controlled
Miraflores	Synchronous-Visual	4	4	Balboa Sub.
Miraflores	Synchronous-Visual	4	6½	Summit Sub.
Gatun	Synchronous-Visual	4	6¾	Cristobal Sub.
Gatun	Visicode	2	1	Gatun Sub.

At Balboa substation 82 operations (with an ultimate of 92) are performed by supervisory control, including operation of circuit breakers, stopping and starting 1,500 kva. condenser, telemetering and various alarms signals. About the same number of operations are done at Cristobal substation. At Summit fourteen operations are performed, and the same number will be used at Gatun when the equipment is installed.



Heating system control board, in the 70-story main building, on which are indicating gages to show steam pressure in heating system risers and zones, and in water heaters; and recording gages for high-pressure steam and the outside temperature

METERS GUIDE OPERATIONS

AT ROCKEFELLER CENTER

ROCKEFELLER CENTER, New York City, when completed, will comprise a group of ten buildings on the three blocks from 48th to 51st St., extending from 5th to 6th Ave. To date, six of these structures, the 70-story main building, 6-story British and French buildings, the 31-story R.K.O. building, and two theaters, have been completed. Power is purchased for these buildings as a group and sold to the different buildings and tenants by the building-operating managers. An extensive metering system has been provided to obtain distribution records of the services to the buildings and their tenants. In these metering operations there are several unusual and interesting features.

Power is supplied from the street high-tension network at 13,200 volts and distribution at 208 and 120 volts, 3-phase, 4-wire. All metering is done on the secondary side. The demand of the entire development is recorded on a printometer-type maximum-demand meter located in the 70-story office building. The power company supplies this demand meter and individual watt-hour meters for every four banks of transformers. The watt-hour meters are all special, being of a three-element type, having as many coils per element as there are banks of transformers connected to them. These meters are equipped with contacts so that maximum-demand impulses are sent to a relay panel in the main meter room where the summation of the coincident 30-min. demands for all building loads is recorded on the printometer. Power is billed to the operating company, based on the maximum monthly demand shown on this meter and summation of all watt-hour meter readings on incoming lines to the buildings. There are installed in each building maximum-demand meters so that each building can be charged its proper proportion for power based on its demand.

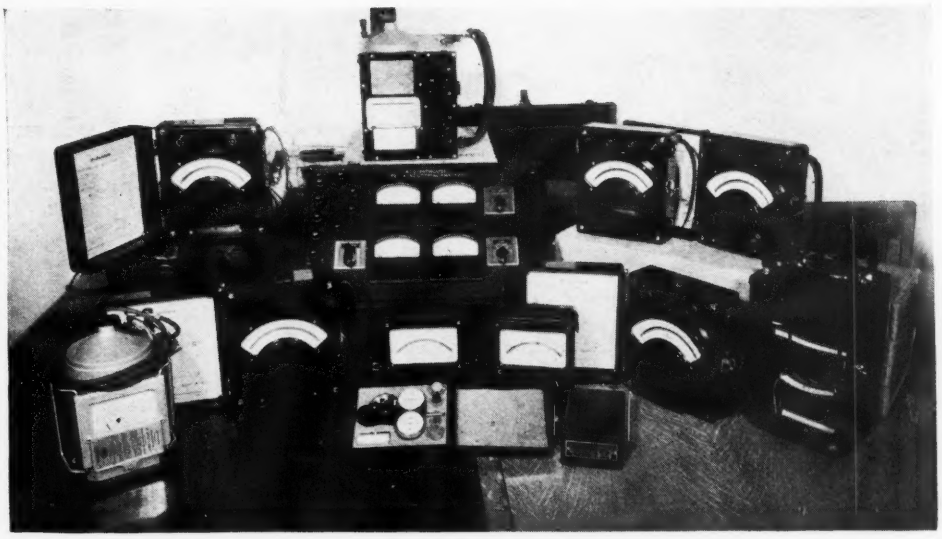
On the main switchboard in each building, energy for power and for lighting is metered separately. Each tenant's power is metered through a watt-hour meter, and for all loads having over one-kilowatt demand, a watt-hour meter having a demand indicator is installed. Where large quantities of power are used, the load, both power and light, may be subdivided and metered in separate units to suit the requirements of the tenants.

The maximum-demand printometer charts are removed weekly and curves plotted showing the coincident half-hour peaks for each unit for the week. The highest coincident daily peaks are taken and used to plot a day-by-year load curve. These curves are being developed to provide data for an intelligent study of building loads so that these may be regulated to improve the load factor and reduce power costs. This work is just getting nicely under way and has not gone far enough to give final results. However, studies made so far show interesting possibilities.

Of building services requiring power, the air-conditioning and elevator loads are the only ones metered. On the air-conditioning loads, both watt-hour and demand records are obtained, and on the elevators, kilowatt-hour, car-mileage and car-stop records are taken.

Meters on the elevators are read daily. From the watt-hour meter and car-mileage records, a daily check is kept on kilowatt-hours per car-mile. As the power taken by an elevator is influenced to a large degree by the number of stops per car-mile, the stop-counter records provide the necessary information to intelligently compare the performance of one car with another. Any unusual increase in power consumption that cannot be accounted for is immediately investigated and the fault corrected.

The building electrical department is provided with an extensive portable metering equipment. One of these meters is a motor analyzer. This device comprises a



The electrical department has extensive portable metering equipment

polyphase wattmeter, a voltmeter to read the voltage of each phase, an ammeter to check the current in each phase and a power-factor meter. This equipment is used to check all the important motor loads in the buildings, and in the case of the ventilating fans the power taken by their motors is obtained from the analyzer readings and cost per hour of operation is estimated. Cost per month is then figured from the fan log, which gives the total hours each fan has been in service.

The pump-motor loads are not metered, but are included in the residue that comprises the distribution and other losses representing the difference between the total power metered to the building and that accounted for on the tenants' meters, the air-conditioning, elevator and fan loads.

As previously mentioned, the electrical department is provided with an extensive set of portable meters. In addition to the motor analyzer, there are two Meggers, one of which is provided with a bridge connection for determining the location of grounds or leaks on feeders; direct-current ammeters and voltmeters with suitable shunts and resistances; alternating-current ammeters and voltmeters with multiple-ratio current and potential transformers; and a combination revolution-counter and stop-watch that allows operators to obtain very close records of speed. The current transformers for the alternating-current ammeters are of the clamp-on type that permits taking meter reading without disturbing any line connections.

Although these meters represent a considerable investment, they have more than paid for themselves in services rendered while the buildings were being put into operation. These meters are now in regular use to keep a check on the condition of the electrical equipment and locate potential sources of failures and of power losses, before they develop into unexpected service interruptions.

Steam is purchased and brought into the different buildings and metered by four meters. Metering arrangements in the buildings vary, but the main building is representative. Two of the meters in that building are for light-load operation and two for heavy loads. The latter are in service during the heating season only and serve the building-heating load. The two light-load meters are on lines that supply the miscellaneous loads, such as kitchen service, air conditioning and water heating. In the summer, all steam is supplied through these meters. Steam to the studio section of the main building is also metered in three ways, air-conditioning load, indirect - heating load and direct heating.

Steam is supplied at 160-lb. gage and is reduced to several different pressures through reducing valves. On the low-pressure side of each reducing valve is an indicating pressure gage to show how the valves are functioning.

All water heaters are equipped with indicating thermometers on the outgoing water lines and mercury-bulb thermometers on return lines to show how this equipment is functioning. On the water heaters are economizers through which condensate is passed from the building heating system. Thermometers are provided on the incoming and outgoing condensate lines to these condensers.

The several air-conditioning systems have extensive metering equipment. The meter board for the air-conditioning and the heating system in the French office building is typical of those on the other five systems in the buildings and theaters. On this board are recording gages for the temperature of the water to and from the condensers and of the condensate, the water to and from the air coolers, in the flash tanks, the air from the four fans, return air, air at the washers' outlets, dew point in the air washer, dry-bulb and wet-bulb air temperatures, steam pressure and gallons of chilled water circulated.

Indicating gages show the air-conditioning heater pressure, receiver pressure, refrigerating-machine steam pressure, flash-tank vacuum, steam pressure to and from each heating zone and the air pressure in air ducts. The valves on the main heating zones are under manual control from this board and indicators show the position of the valves. The operation of the valves can also be thrown from manual to automatic control.

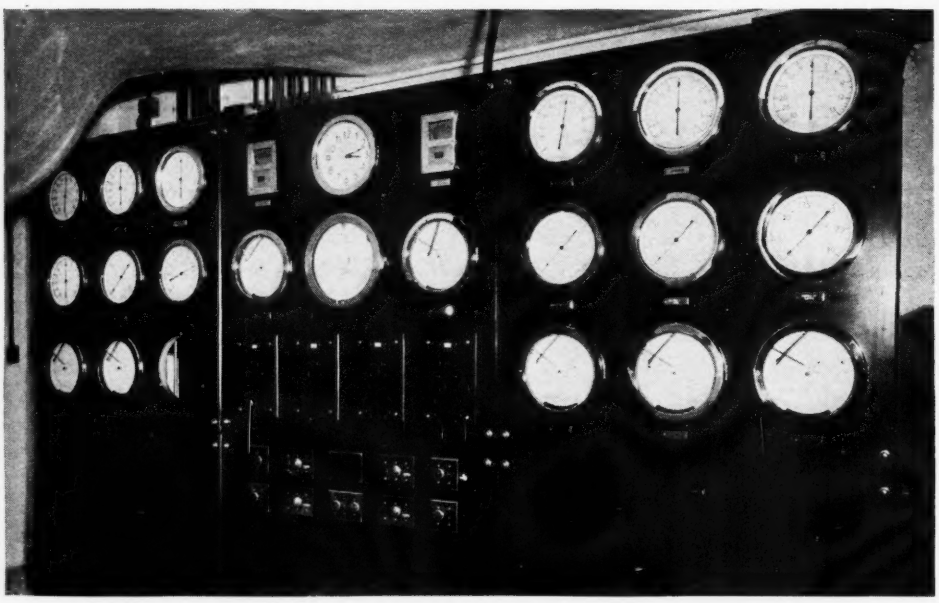
In addition to meters on this board, there is a Micromax hydrogen-ion indicator to show the hydrogen-ion content of the water used in the air washer, which is maintained at a certain value by chemical treatment. There are also other gages and meters for different purposes located at convenient points where they are needed for an intelligent understanding of how to adjust units of equipment.

On the gage board in the heating-system control room of building No. 1, are indicating gages to show the pressure to and from each of the eleven heating zones, the pressure in the various risers to the heating system, steam pressure on the water heaters and recording gages for the incoming steam and outside temperature. On this board are also the control of zone pressure regulating valves and indicators to show position of the valves. These valves may be thrown on manual control and operated from the board or they can be switched to automatic control and regulated by temperature in the zones.

There are also indicators on the board to show if the important ventilating fans are running or shut down. From these indicators, a log of fan operation is compiled.

By the use of this extensive metering system, it is possible practically to operate the plants under test conditions. A log is compiled for each 8-hr. shift that gives a comprehensive picture of operating performance.

Power is indebted to T. K. Torgesen, electrical engineer of Clyde R. Place, consulting engineers, and to D. Ross Watson and H. C. MacNary, Operating Department, Rockefeller Center, Inc.



Meter board for air-conditioning system in French building

FORSTMANN WOOLEN ADDS POWER GENERATION

(Continued from page 561)

Boiler leads supply steam to either one of two high-pressure cross connected headers from which steam is distributed. Auxiliary steam and exhaust systems are sectionalized type so that steam for deaeration and the principal auxiliaries is always available.

A sluicing system disposes of ash removed from the furnace bottom and soot from the last boiler passes. All of these wastes together with the drains from the flue gas scrubbers are discharged to an ash settling pit from where they are pumped to an overhead dewatering and storage tank and removed to a dump by truck.

The turbine room is separated from the boiler room by a glass partition providing a maximum of light at the rear of the boilers. It contains one 1,250-kw. unit, one 300 kw. unit and one 750 kw. unit. designated as units Nos. 1, 2 and 3 respectively. Unit No. 1, a new machine, takes steam at 225 lb. pressure and is arranged for extraction at 35 lb. pressure. No. 2 is also a new unit, taking steam at 225 lb. pressure and arranged for straight condensing. No. 3 is a rehabilitated unit relocated from the Forstmann Woolen Co. Garfield power plant. This unit, together with unit No. 2, is used principally as standby for No. 1.

Although the process steam requirements of this plant usually exceed the maximum extraction delivered by unit No. 1, this steam load is not of such proportions as to make it possible to operate at all times without condensing facilities. An oil-operated non-return valve in the extraction line, arranged to trip whenever the unit shuts down, protects against over speed caused by steam from other sources flowing into the turbine through the extraction opening.

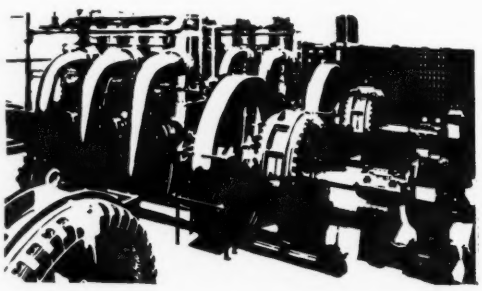
Units Nos. 1 and 3 are provided with two-pass condensers, each having approximately 800 sq.ft. of condensing surface. The tubes are rolled into each tube sheet and relative expansion is taken care of by an expansion joint in the shell. Condenser shells are carried directly on the structural steel turbine supports, expansion being taken care of by copper expansion joints between the turbines and the condensers. Air is removed by two-stage steam jets with surface type inter and after condensers.

There are two condensate pumps for each condenser and two circulating water pumps for the entire plant. The condenser for unit No. 2 is a "Navy" type unit with internal air cooler, one two stage steam jet air removal and surface type inter condenser and after condenser.

Since the output of both steam and electricity is distributed to a large number of departments, it was necessary to provide as many meters and instruments as could be justified.

Steam flow meters are installed in each boiler lead and in the high- and low-pressure lines to the manufacturing plant. Feed water is measured by a Venturi meter in the suction line to the boiler feed pumps. Meters have been provided in the City water supply to the power plant and in the water supply lines to the manufacturing departments requiring heated water from the power plant. Provision has been made for recording the pressure and temperature of steam and water supply for process purposes.

Correction—In the October number, in the article "Why and How Compressed Air Should Be Cleaned," Staynew Filter Corporation should have been included as a manufacturer of pipeline filters for cleaning compressed air.



POINTERS ON OPERATING MECHANICAL OIL BURNERS

By HARRY M. SPRING
Milford, N. J.

DUE to the increased number of oil-burning installations during the past few years a few pointers on operation and maintenance may prove beneficial to plant engineers having charge of this type of equipment. The following applies more to the larger installations in power plants than to heating plants using lighter grades of fuel oil.

To secure best results, the fuel oil should be delivered to the burners at nearly constant temperature. This may be controlled by means of a temperature regulator varying the amount of steam to the heater coils to suit the grade of oil and the demand. No one temperature can be recommended for all grades of oil, and adjustment of the regulator may be necessary to allow for variations in each shipment of oil received.

Too high an oil temperature produces an orange or yellowish flame accompanied by black smoke. The fire in this case will usually burn in puffs or blasts and may be so unstable as to extinguish the flame and cause serious flarebacks. On the other hand, if the oil temperature is too low, ignition will be difficult and the fire will have a tendency to go out on low boiler loads. The approximate temperature may be determined by finding the viscosity at various practical operating temperatures. Good results should be had when the oil is heated to a temperature giving a viscosity of 175 to 200 Universal Saybolt seconds.

The experienced plant engineer can tell a great deal about oil-burner performance by a glance at the smoke from the stack. A light gray or brown haze usually indicates good combustion. If a heavy black smoke is emitted it generally indicates too high an oil temperature, insufficient air or incomplete combustion. If a number of burners with different-size tips are operated in the same furnace it will be found nearly impossible to get good combustion. Correct air supply for one size of tip will be excessive or deficient for another.

Care should be exercised when selecting the size of tip to use in burners. Too small a tip will usually cause excessive carbonization on overloads. It will be found impossible to maintain constant steam pressure under varying loads because the small tip will have a slow pickup on peaks. When the tips are too large for the average steam-load, operation will be very unsteady with the master regulator remaining closed and the oil flowing through the low-load bypass the greater part of the time. This will of course result in lowered operating efficiency.

More than one burner is generally used on large boilers and it is common practice to control the rate of steam generation for a wide demand by cutting burners in or out of service. This method has the objection of carbonization and overheating the idle burner by the radiant heat of the fire. Recent designs of mechanical oil burner provide for bypassing a portion of the oil from the central passage back to the oil pump suction. This allows a reduction in burner capacity without destroying the effective velocity or atomizing power.

With the type of burner having a rotating bowl, the gun is usually demountable. When shutting down this type of burner, first shut off the oil-supply cock. After several minutes with the air supply on full to clean the feed tube and bowl, the air supply or blower is shut down. The burner should then be immediately removed from its mounting to prevent it from becoming overheated. Overheating is liable seriously to impair the burner's performance by distorting the rotating parts. At least once each day the burners should be cleaned, and this should be done as soon as possible after they are removed from service.

Kerosene is effective for cleaning but the burner should not be allowed to remain soaking during the time it is out of service. Excess kerosene should be drained out and a good grade of light lubricating oil applied to all moving parts that might rust.

Care should be taken in handling this type of burner to avoid nicking or scratching the edge of the rotating bowl. Such injuries to the burner may cause a spray of wet vapor from one side of the bowl and result in excessive carbon formation and a higher furnace temperature on one side, with possible flame impingement. It will also cause the rotating parts to become unbalanced and result in more rapid wear of bearings. When cleaning, care must also be taken not to enlarge or score the edge of the oil ports in the tips with the wire or other cleaning tool.

Carbon formation in small amounts on the furnace bottom or refractory surface surrounding the burners is not an indication of trouble. It should, however, be broken up with a bar and removed or pushed forwards and burned up. An excessive accumulation of carbon directly under the burner may cause it to become overheated. If it forms in large amounts, it is an indication of improver atomization, probably due to one or more of the previously mentioned causes.

If the fire is extinguished with the oil supply flowing, the operator should immediately close the oil valve, open all dampers and increase the supply of air from the fans to a maximum. He should not attempt to relight the burners until at least one minute has elapsed from the time of shutting off the oil supply and never before all smoke, haze or vapor has entirely cleared from the furnace. When the fire goes out with the oil turned on, a heavy yellowish smoke will appear from the stack. The burner should always be ignited with a torch or some type of internal ignitor and never from the heat of the furnace walls. Failure to observe any of these rules when relighting an accidentally extinguished oil fire may easily result in a serious flareback and injury to the operator.

BETTER ENGINEERS!

Engineers' Council for Professional Development proposes far-reaching plan to guide prospective engineering students, rate engineering schools, direct the training of engineering graduates, establish uniform grades of membership in engineering societies, and give official recognition

BY JOINT authorization of the American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Society of Civil Engineers, American Institute of Mining Engineers, American Institute of Chemical Engineers, Society for Promotion of Engineering Education, and National Council of State Boards of Engineering Examiners, the Engineering Council for Professional Development was organized in October of last year. The purpose of this organization is to raise the standing of professional engineers. It aims to coordinate and promote efforts and aspirations directed toward the higher professional standards of education and practice, greater solidarity of the profession and greater effectiveness in dealing with technical, social and economic problems.

October 10 of this year the Council held its first annual meeting in the Engineering Societies Building, New York City. Far-reaching recommendations were made and agreed upon, dealing with a program for accrediting engineering schools, the establishment of a policy for professional recognition of the engineer, a minimum definition of the engineer and a suggested scheme of uniform grades of membership in professional societies. Four committees presented reports, but that on professional recognition will be of greatest interest to *Power* readers.

This committee recommends that the profession should establish as the goal of attainment a series of qualifications for which the young man, whether graduate or non-graduate, may successfully strive from the time he enters upon an engineering career. This goal of attainment, embodied in a certificate equivalent to a professional degree and having a value recognizable as adequate to entitle the holder to licensing or registration in a state, should be based upon the following features:

A. Certification should be earned and not granted as a mark of honor.

B. The code of educational qualifications should be more advanced than graduation from college, yet attainable by both college and non-college men.

C. The attainments should be tested individually by examination (written and oral), or the equivalent, and not gaged by the personal estimates and testimonials alone.

D. Educational qualifications should comprise scientific, technical, economic and civic knowledge of a mature order.

E. The code of experience qualifications should normally make the age of certification fall between 25 and 30.

F. The ultimate certification into the profession should be the objective to which both the college and the professional societies should exert their influence. To this end the colleges should be encouraged to aid, by granting the professional degree to those who have been thus certified.

G. The certificate into the profession should be the means by which the state registration boards would, with confidence, recognize those essentials which they observe as requisites for the registration of engineers.

H. And, similarly, the certificate into the profession should be *prima facie* evidence of technical proficiency for admission into the corporate membership of the societies.

The following minimum qualifications for an engineer were adopted for recommendation to the Engineers Council for Professional Development:

A. Graduation from an approved course in engineering of four years or more in an approved school or college; a specific record of an additional four years or more of actual practice in engineering work of a character satisfactory to the examining body: (The examining body, in its discretion, may give credit for graduate studies in counting years of active practice), and the successful passing of a written and oral examination covering technical, economic and cultural subjects, and designed to establish the applicant's ability to be placed in responsible charge of engineering work and to render him a valuable member of society.

Or:

B. Eight years or more of active practice in engineering work of a character satisfactory to the examining body, and the passing of written and oral examinations designed to show knowledge and skill approximating that attained through graduation from an approved engineering course, and also examinations, written and oral, covering technical, economic and cultural subjects designed to establish the applicant's ability to be placed in responsible charge of engineering work, and to render him a valuable member of society.

Uniformity in the grades of membership of the various societies, and conformity with the above minimum standards, are logical and desirable. Accordingly, the committee agreed upon the following designations and specifications to be recommended to the participating bodies of the E.C.P.D. for the grades of membership:

Student Members: A person matriculated in an approved school or pursuing studies in accord with the program of the Committee on Professional Training.

Junior Member: A graduate of an approved school, or one who has passed equivalent written and oral examinations.

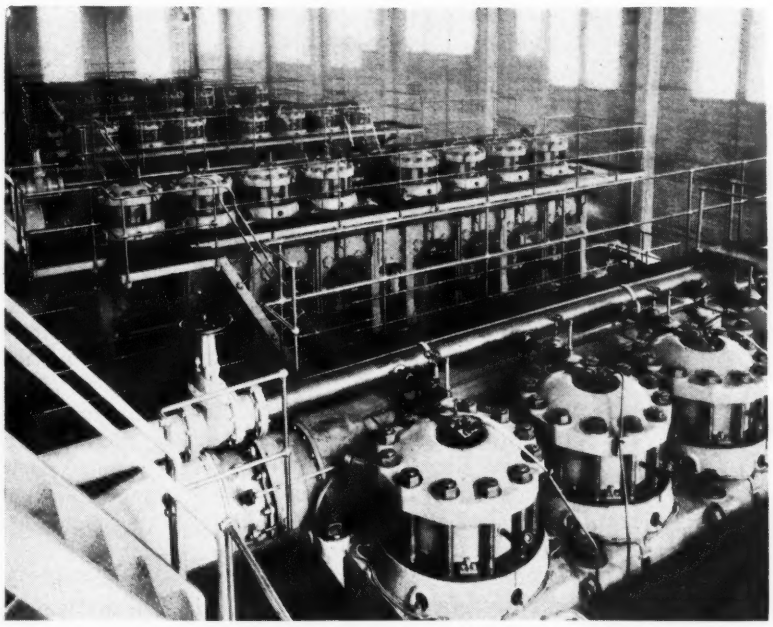
Member: A full-fledged engineer who has passed the requirements in the minimum definition of an engineer.

Fellow: This grade is for recognition of the more mature engineer.

In accordance with the policy established above, the grade of membership, the license and the professional degree should be in substantial agreement with the minimum definition. The committee urges that steps be taken to place this view before the faculties of engineering schools for consideration, so that in time the grades of professional recognition will be made uniform.

At the meeting, permanent officers were elected, consisting of members of the Executive Committee: J. Vipond Davies, A.S.C.E.; Donald F. Irvin, A.I.M.E.; William E. Wickenden, A.S.M.E.; Charles F. Scott, A.I.E.E.; H. C. Parmelee, A.I.Ch.E.; Robert I. Rees, S.P.E.E.; David B. Steinman, N.C.S.B.E.E. C. F. Hirshfeld was elected chairman and C. E. Davies secretary.

35,000-HP. DIESEL PLANT AT VERNON, CALIFORNIA



BEGINNING operation in June, America's largest diesel generating station, built by the Department of Light and Power of the city of Vernon, California, gives promise of being the beginning of a revolutionary change in central-station power generation practice. Careful consideration of the physical characteristics of the locality have enabled the designers to make this plant one of the most outstanding engineering accomplishments in recent years. Representing the most advanced thought in central-station design, Vernon shows how a modern layout, new electrical apparatus, and the pioneering spirit can be combined to produce an efficient and flexible plant, adapted to the needs of the community, with an extremely low investment per unit of installed capacity.

Vernon is an independent isolated municipality, approximately 4 sq. miles in area, completely surrounded by other incorporated areas. It is highly industrialized, with many of the large factories and heavy industries of southern California within its corporate limits. The area has a load density at the present time of approximately 10,000 kw. per square mile. An interesting sidelight is the fact that the $3,900,000 bond issue for the construction of the plant was passed by a vote of 69 to 3.

To fully appreciate the circumstances surrounding the construction of this plant, it is necessary to visualize a compact area of high load density, having its electrical load center coincident with the geographical center of the community. Add to this the fact that from all practical standpoints it was possible to utilize property at this point for a power plant, and the proposition resolved itself into something that resembles paradise for the power-plant engineer.

In supplying the power plant and distribution system for this area, probably the most important feature, and the one most likely to have far-reaching future effects on power generation practice, is the type of prime mover selected to drive the generators.

For the first time on the American continent, diesel engines have been used to drive the generators of a major power station. The building housing the plant is of structural steel and reinforced concrete construction, as modern in architecture as the plant is in engineering. In so far as possible, a unit type of construction has been carried out, so that each prime mover and its generator is an independent operating unit complete with its own accessories. This unit design has been carried from the engine through to the outgoing feeders.

The present installation of 37,500 kva. consists of five 7,500-kva. units. Each unit consists of a 7,000-b.hp., eight-cylinder, double-acting two-cycle, 167-r.p.m. diesel engine, direct connected to a 7,500-kva., 0.8 power factor, 7,200-volt, 50-cycle generator. These Hamilton-M. A. N. engines, built by the Hooven, Owens, Rentschler Co., are the largest now in stationary service in the United States. They are of the solid-injection, double-acting, two-cycle, cross-head type, which, with an eight-cylinder engine, provides the exceptionally smooth flow of sixteen power impulses per revolution, delivered to the crank shaft. These engines have cylinders of 24-in. bore, with a piston travel of 36 in.

Units are designed for minimum operating and main-

tenance cost. The cylinder block is separate from the crank-case housing, cylinders for each engine being in two groups of four in line, with fuel pumps and other auxiliaries for each cylinder correspondingly segregated.

Pistons are made up in four parts, the upper end being a steel forging and the lower a steel casting. These two sections are bolted to a shoulder on the piston rod, a cast-iron guide ring with a skirt to fill the space between the two sections being bolted in between. The pistons carry five angle-jointed standard rings on each end, two of which are of the oil control type. Pistons are internally water cooled, the water entering through a telescopic feed line which terminates at the bottom of the piston rods. Water outlets from the pistons are similarly arranged.

In a double-acting engine each piston receives a power impulse on both the up and the down stroke. The upper side of the piston is of the conventional design with fuel oil sprayed in at the top through a single fuel-oil valve. Fuel injection on the lower side of the piston is necessarily complicated by the presence of the piston rod. Two fuel valves are used on the lower side.

A double row of scavenging and exhaust ports is provided in each cylinder, the exhaust ports being placed between the cylinder head and the scavenging air ports. Scavenging air, under 2-lb. pressure, is forced through the scavenging air ports, sweeps across the cylinder, works upward toward the cylinder head, across the latter and down to the exhaust ports. This insures a thorough cleaning out of the cylinder, and the circular motion thus imparted to the air persists during compression and improves the mixing of fuel and air for the next power stroke. Thus scavenging air exhausts the waste gases and leaves a fresh charge to be compressed on the return stroke, at the top of which fuel oil is injected for the next power impulse.

With sixteen impulses per revolution the heavy generator rotor supplies all needed flywheel effect. No separate flywheel is used.

The cylinder head has two pieces, the inner section being a water-cooled steel casting. The cylinder liner, also, is in two parts, inserted from above and below respectively.

Engine Lubrication

Cylinder and crank-case lubrication are kept entirely separate for maximum economy and best operating results. From yard storage the cylinder oil is pumped to a roof tank, then flows to the engine lubricators. These supply oil, in timed shots, to 12 cylinder (and rod) feeds on each cylinder.

Bearings in the crank case assembly are lubricated from an entirely separate system. The crank case shaft assembly is isolated from the cylinder blocks so that lubricating oil in the former cannot be contaminated by carbon from waste gases or diluted with unburned oil. For this reason, it is expected that one charge of lubricating oil for the crank-shaft lubricating system of each unit will last approximately 5 years.

Crank-case oil is handled individually for each engine, passing in a continuous cycle through filters, cooler and tank to the engine-driven lubricating oil pump which forces the oil through the moving parts of the crank-case assembly. From these it returns by gravity to the pump tank.

From two storage tanks holding 15,000 to 9,500 bbl. of oil, respectively, fuel oil is pumped through centrifuges to individual day tanks on the roof. The discharge of each fuel injection pump is regulated by a governor-controlled bypass valve.

Each diesel engine requires approximately 27,000 c.f.m. of air at rated capacity. This is provided through five air washers, and five blowers, one for each engine. The blowers, driven by 400-hp., 3,000-r.p.m. induction motors, draw the air through the washers and force it through the ports in the cylinder walls. As each cylinder of a double-acting engine exhausts above and below the center scavenging ports, two exhaust manifolds per engine are required. Under normal operating conditions, the waste gas and scavenging air exhaust at temperatures ranging from 525 deg. to 625 deg. F.

Cooling System

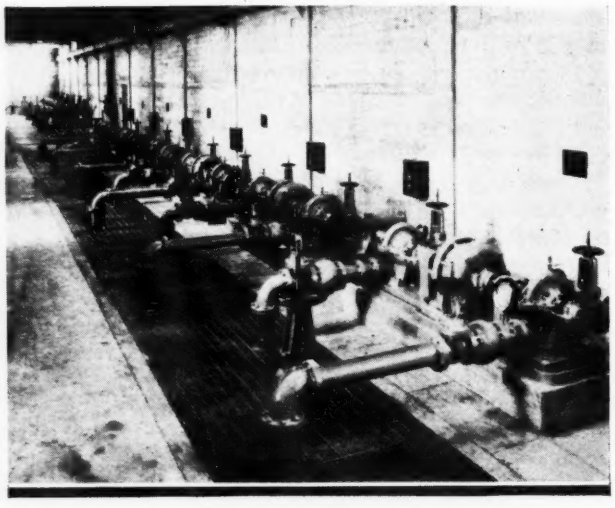
In addition to complete water jacketing of the cylinder blocks, the pistons and rods are water cooled. Experience has shown that impure cooling water will form scale on the inside of water jackets and pistons, an extremely undesirable situation which reduces efficiency and increases maintenance costs. To prevent this an unusual cooling water system has been installed, in which distilled water, produced as a byproduct of the engine operation, is circulated through the cylinder jackets and piston cooling water passages.

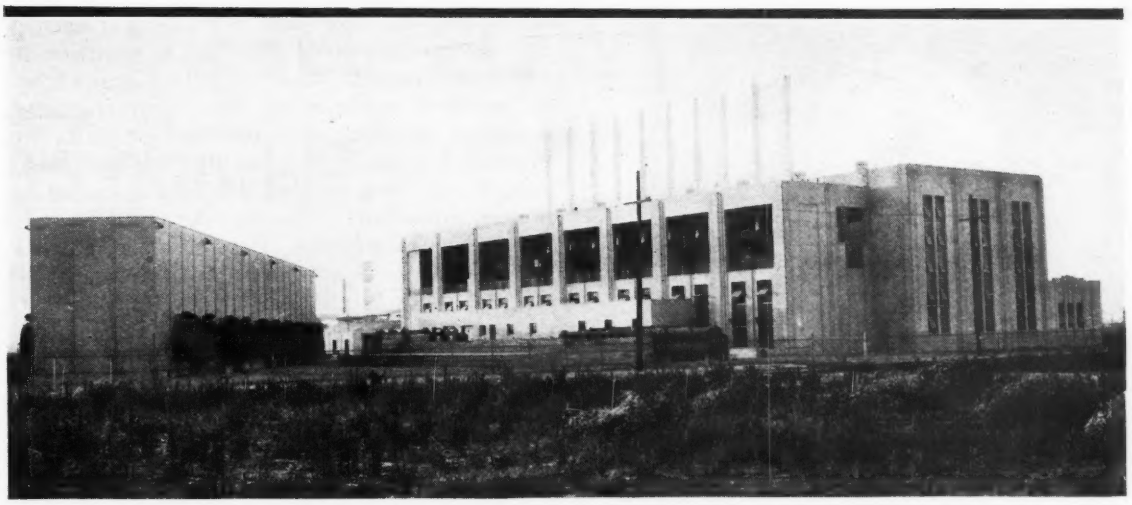
Distilled water is produced by utilizing waste heat in the exhaust manifold of the engines. As the engines exhaust at both the top and bottom of the cylinder, two exhaust manifolds are necessary, each of which terminates in an individual waste-heat boiler. Heat from the exhaust gases thus is utilized to generate steam which is used in a conventional double-effect evaporator system. The distilled water produced is used as makeup for the engine cooling-water system.

The cooling-water system is of the double-circuit enclosed type. In one section the distilled water circulates in a closed system, consisting of a closed concrete reservoir, one side of the heat exchangers, circulating pumps and water jackets of the cylinders and pistons.

In the heat exchangers, the distilled water gives up its heat to raw water, which also is in a closed circulating system, consisting of the heat exchanger, pump and cooling tower. Heat removed from the engines thus passes from the distilled-water system into the raw-water system at the heat exchanger and is eventually dis-

Motor-driven pumps serve closed-circulation systems for engine cooling.





Rear view of plant, showing waste-heat boilers on balcony, and also (left) the sectionalized cooling tower.

sipated in the raw-water cooling tower. The cooling tower is of the forced-draft type, sectionalized to conform to the unit scheme of operation which characterizes the plant design. Each section is designed to dissipate the 17,000,000 B.t.u. removed from one engine and its accessories, at rated load.

Shop tests gave the following unit fuel consumption in pounds per brake-horsepower hour. Net consumption is based on the net brake-horsepower (actual less the power consumed by the blower):

	Half Load	Three-Quarter Load	Full Load
Lb. per brake-hp.....	0.347	0.347	0.364
Lb. per net brake-hp..	0.384	0.371	0.383

Engine Control

Control for the engine units is provided by individual three-panel, engine control boards, installed directly behind each engine in the generating room. On one panel are mounted the pushbutton switches for starting the auxiliaries for that particular engine. By using magnetic control for all auxiliaries it was possible to arrange the pushbuttons in a group so that the operator, in starting the unit, presses successive "start" buttons in the logical sequence from left to right and top to bottom. Operation from a cold start takes less than 2 min.

In addition, the remaining panels mount pyrometers and water temperature and pressure indicators. One unusual item is the use of a teleindicator on each control panel to relay commands between the station control board and the engine control panel. This device is similar in operation to the conventional engine-room telegraph used aboard ship.

Control of Load and Frequency

With governors of the usual type, speed must reduce slightly as load goes up. An interesting feature of the Vernon plant is the complete Leeds and Northrup automatic load and frequency control. In each governor is a special spring, the compression of which is controlled by a small reversing field direct-current motor. This acts as a micrometer adjustment on the governor, so that the speed may be adjusted to normal regardless of the load carried.

This mechanism is constantly adjusted by automatic impulses received from the load and frequency control instruments. Any unit may be connected to the master frequency controller. In addition the individual load controller of each unit may be set to assist the master in frequency regulation on proportionate load distribution or to maintain a fixed load.

The master frequency controller is sensitive to frequency variations of 0.01 cycle. Deviations from the 50-cycle control point send correcting impulses to the governor motors.

Automatic load and frequency control here serves the same purpose as in hydro electric plants, except that the application is more satisfactory since there is no need to contend with the inertia effect of large masses of moving water. Changes in the governor setting of a diesel engine immediately change the fuel feed.

Compressed air for starting is contained in a bank of ten steel bottles, located in the west end of the generating room. Each bottle contains 36 cu.ft., or sufficient air for ten "starts." A high-pressure, three-stage, motor-driven air compressor automatically maintains this compressed-air reserve.

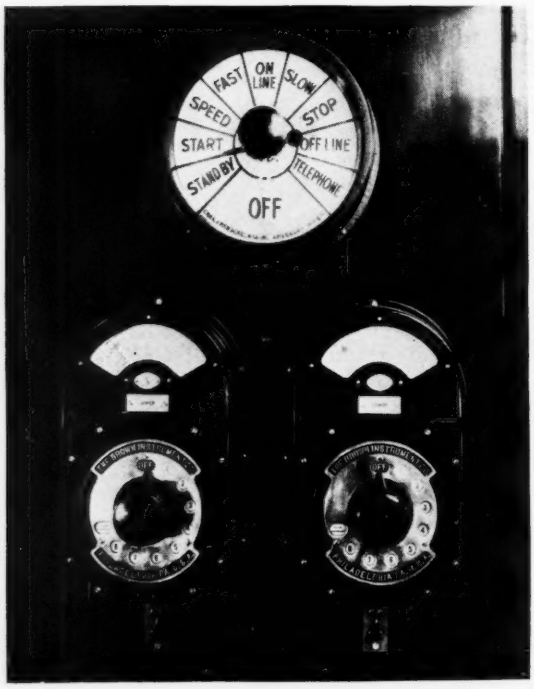
In addition, a twelve-cylinder, 1,000-r.p.m., 600-hp. Winton high-speed gasoline engine unit, arranged for quick start, is direct connected to a 500-kva., 0.8 power factor, 2,300-volt, three-phase, 50-cycle generator with direct-connected 4-kw., 250-volt exciter for emergency starting. This unit is of sufficient capacity to start a scavenging blower with the necessary water circulating pumps essential in the diesel engine's operation.

Five units are now installed in the engine room, the present building being designed to accommodate two additional units without change. A temporary wall at the east end of the building makes further expansion possible for an ultimate of ten engines. Auxiliary pumps and blowers are installed at the rear of the engine room. Pumps are grouped according to the function they perform and, in most cases, it is possible to interchange pumping units so that the circulating water or fuel supply for one unit can be obtained through the corresponding pumping unit of any other engine unit.

Electrical Installation

In the design of this station the advantages of metal-clad switchgear equipment have been fully realized. The main 7,200-volt switching center is a group of 36 switchgear units installed in two switchgear rooms paralleling the engine bay and separated by the station control room.

The switchgear carries out unit assembly idea charac-



Close-up of the temperature recorder and engine-room telegraph on engine control panel

teristic of the plant; five main and five reserve bus switchgear units connect the leads from that number of generators to the double buses.

In addition to the main 7,200-volt switching assembly, two other metal-clad groups furnish 2,300-volt and 460-volt station auxiliary power, respectively. By using the metal-clad combination the exposed bus is entirely eliminated, with the consequent improvement in operating and maintenance conditions and the increased safety to operating personnel. In the basement of the electrical bay, five individual metal-clad units are provided for solidly grounding the generator neutrals to a common grounding system.

Complete remote control for the plant is embodied in a 21-panel, semicircular, ebony asbestos control board of the combination bench and vertical instrument board type and a full-height relay board mounted back to back with an aisle space of 4 ft. 6 in. between.

Mounted on the generator panels, in addition to the usual indicating instruments and control switches, are the engine-room signal transmitters and indicators and the four-position frequency control switches for selecting and setting the unit load controllers of each generator for any predetermined base load, proportionate load or automatic frequency control setting desired.

The same attention to detail that characterised the design of the plant itself has been given its distribution system. Unusual is the fact that the unit idea has been carried out even to the distribution feeders. At the present time sixteen feeders take power from the plant into the consumer area. Because of the small area supplied (4 sq. miles) its predominantly industrial character, and other special load conditions, distribution is at the generator voltage of 7,200.

Conclusions

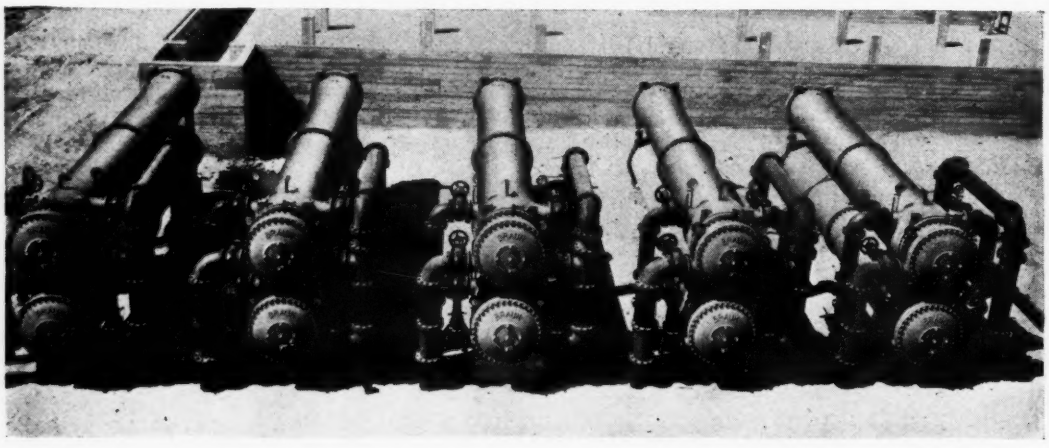
Aside from the very important fact that diesel engines are used for the first time to drive the generators of a major American central power station, the most important feature of this system is the design which combines uniform unit groups of equipment to make up the whole. Actually the plant consists of five duplicate 7,500-kva. generating units complete to the last detail.

While operating and cost data are not as yet available, and while the area it serves has certain characteristics favorably affecting its design, this pioneer diesel-driven, large-scale central station power plant gives promise of widening the scope of diesel power generation as applied to utility service. Not only has the diesel engine been proven as a satisfactory prime mover from the service standpoint, but also has the use of modern "package" equipment been shown to be effective.

The design and construction of this plan and system was under the supervision of the city engineer, Howard McCurdy; Wayne N. Johnson, electrical engineer, and Carl A. Heinze, consulting engineer.

Some Major Equipment and Makers

Main Engines (Hamilton—M.A.N.)	Hooven, Owens, Rentschler Co.
Main Generators & Exciters	Allis Chalmers Mfg. Co.
Generator Air Coolers	Griscom Russell Co.
Emergency Gasoline-Driven Unit	Winton Engine Co.
Fuel & Lubricating Oil Filters	Cuno Engineering Co.
Centrifuges	Goulds Pumps, Inc.
Scavenging Blowers	Allis Chalmers Mfg. Co.
Scavenging Air Washers	Buffalo Forge Co.
Engine Cooling Pumps	Allis Chalmers Mfg. Co.
Heat Exchangers	C. F. Braun Co.
Raw Water Pumps	Byron Jackson Co.
Cooling Tower	The Marley Co.
Waste-Heat Boiler (Foster Wheeler)	Built by Consolidated Steel Co.
Evaporators	Griscom Russell Co.
Air Compressor	Ingersoll Rand Co.
Engineroom Crane	Whiting Corp.
Frequency Regulation	Leeds & Northrup Co.
Voltage Regulation	General Electric Co.
Switchboard & Engine Control Panels	W. A. Benjamin Electric Co.
Switchgear	Delta-Star Electric Co.
General Contractors	Mittey Bros. Const. Co.

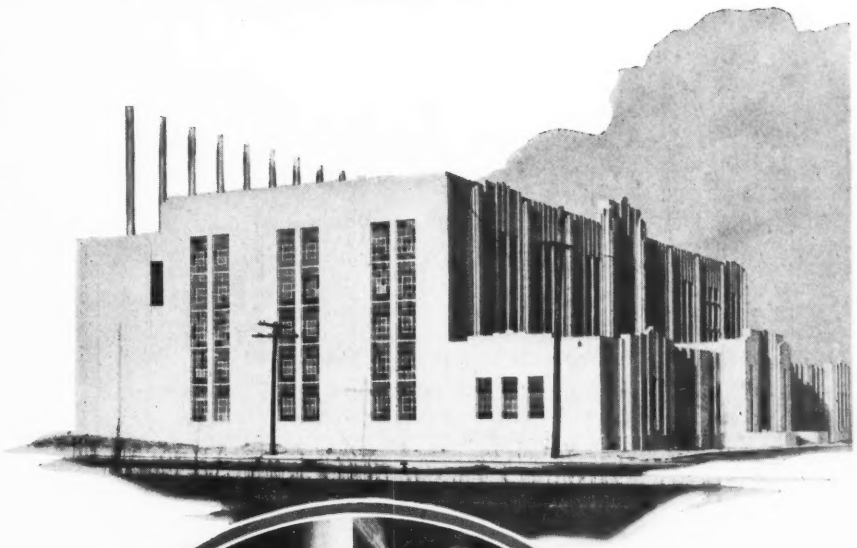


Heat exchangers installed behind the power station. Distilled water, flowing in the closed circulating system, here gives up its heat to raw water, later circulated through the sectionalized cooling tower.

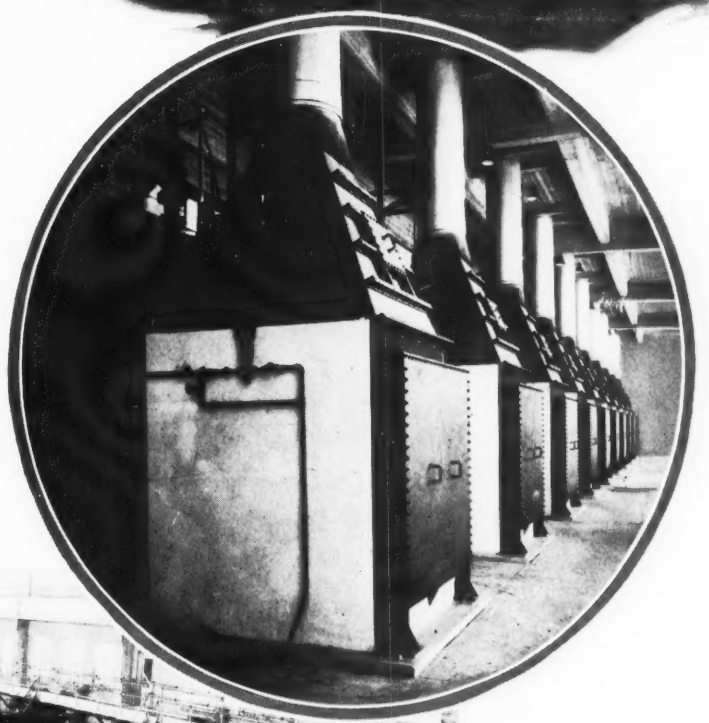
DIESEL POWER PLANT

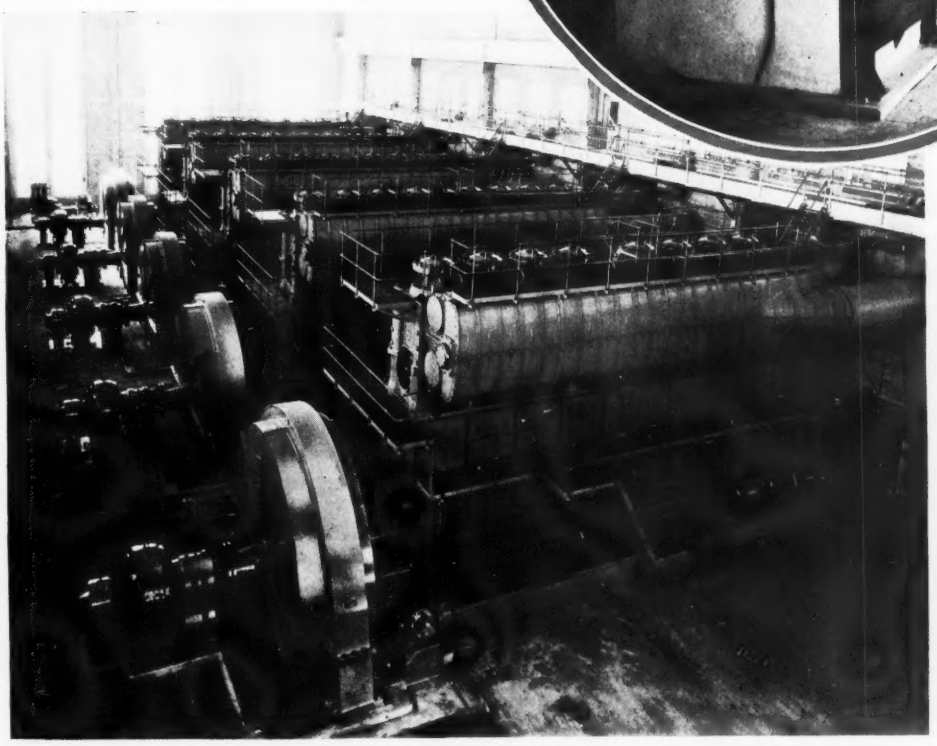
35,000 HP.

CITY OF VERNON, CALIFORNIA



The 35,000 - hp. diesel - electric power plant, built for the City of Vernon, California, is now in operation. Below are shown the five 7,500-kva. generators, each driven by an 8-cylinder, 2-stroke-cycle, double-acting, 7,000-hp. Hamilton-M.A.N. diesel engine





Elaborate precautions are taken to avoid scale formation in the engines. Waste-heat boilers (above) supply steam to double-effect evaporators furnishing distilled makeup to the primary closed-circulation cooling system.

DIESEL CYLINDER LUBR

● Diesel engines have high temperatures and pressures and are customarily used under heavy-duty conditions which impose an additional strain on the bearing surfaces. This monograph covers various resulting difficulties which must be satisfactorily solved to insure good service. Monograph No. 7 on Diesel Power Plant Lubrication covers lubricating oil characteristics and requirements.

Due to the large diameter of Diesel cylinders, wear is of considerable economic importance because any increase in diameter results in over a three-fold increase in ring gap. This increase in ring gap in the case of slow speed engines may cause a serious loss of compression making it difficult to carry full load. Thus after the cylinder has increased about 0.1 inch in diameter it frequently is necessary to replace the liners to secure satisfactory operation.

The bad effects of cylinder wear can be minimized by the use of double rings which do not have a gap permitting blow-by but such rings are more easily broken, are more readily stuck by carbon deposits and are more expensive. Furthermore, they will not take care of irregularities in cylinder wear which in some cases permits the compressed gases to blow by the bearing surfaces.

On one cylinder where blow-by was indicated by dark streaks on the rings and cylinder walls, the average variation in diameter was 0.0042 inches when measured at 15° intervals around the circumference. Another cylinder which did not show such evidence of blow-by had an average variation in diameter of 0.0026 inches.

Cylinder wear with its attendant difficulties can also be minimized by the following:

A.—Large quantities of air pass through Diesel engines, which when taken from dusty surroundings, will contain considerable abrasive material, much of which adheres to the working parts. Efficient filters have caused marked reductions in maintenance and lubrication costs in such cases.

B.—Fuel oils particularly of heavy grade, sometimes contain sufficient suspended solid matter and water to cause excessive wear. These impurities also may clog spray valves, often causing irregular firing. Dribbling of the injection valve or misfiring tends to dilute the lubricating oil with unburned fuel and further contributes to excessive wear. Fuels should be clean and of good quality or they should be filtered or centrifuged.

C.—Solids from air or fuel will in part find their way to the lubricating oil, together with carbon and soot from blow-by and metallic particles from engine wear. In the case of engines using only new oil on the cylinders, this affects the crankcase oil alone. Where the same oil is used in the crankcase and on the cylinders and the used oil is recirculated, the abrasive material contributes directly to wear. It assists materially in ring sticking by accumulating in the spaces between rings and grooves and in back of the rings. Stuck rings cause lose of power, increased blow-by and more rapid oil deterioration. These difficulties should be kept at a minimum by thorough continuous filtering or centrifuging.

D.—Adequate inspections should be made to see that sufficient oil to provide an oil film, reaches all parts of the cylinder but excess oil must be avoided. Excess oil tends to stick rings and is the primary cause of carbon deposits in the exhaust passages. Clogged exhaust passages reduce the volumetric efficiency, hence from all angles excess oil tends to increase wear and maintenance charges.

Small high speed engine cylinders are usually lubricated by splash but the amount can be controlled by the use of oil wiper rings or the installation of baffle plates. Slow speed engines are equipped with forced feed lubricators which should be adjusted to supply the correct quantity of oil. Some cylinders are lubricated by one line which branches to two points on the cylinder wall. One of the branches invariably becomes clogged in a short time, resulting in all the oil going to the other branch. Such systems should be replaced with a pump and line for every point on the cylinder requiring lubrication.

E.—Satisfactory operation of multi-cylinder Diesel engines can only be obtained if the power output of each cylinder is substantially the same, otherwise in an engine running under part load, one cylinder might be seriously overloaded with consequent destruction of the lubricating oil film while other cylinders might not be doing their share of the work. Power output per cylinder can be determined from an indicator card, or approximately and more easily, from the exhaust gas temperature. In the latter case differences between cylinders of more than about 20°F. should not be allowed to continue for long. Such differences indicate variations in load beyond the probably error in the Pyrometer, providing the terminals are clean and not covered with carbon deposits.

F.—Air compressor cylinders frequently are difficult to lubricate because condensed moisture in the cylinders and in the cooler collects on the cylinder walls, causing serious corrosion. This can be minimized by using oils especially compounded to resist the washing action of water. Explosions sometimes occur in air compressor cylinders because of oil accumulations in the inter-coolers which at times of high load or inadequate cooling may ignite and cause serious damage. Oil usually should be supplied at a rate not greater than 0.05 pint per ten hours for a rubbing surface of 500 square feet per minute. The oil feed should be kept to a minimum by frequent adjustment after inspection of the cylinders. Explosions can be minimized by preventing extreme temperatures and keeping the inter-coolers clean both of oil and scale. Excess oil can be avoided by installing splash guards to keep crank case oil off the cylinder walls and by avoiding the creation of high vacua in throttling the compressor, which may cause oil to be drawn up into the cylinders where it may be deposited in the inter-coolers.

STANDARD OIL COMPANY
(Indiana)
910 S. Michigan Ave. Chicago, Illinois

BRICATION DIFFICULTIES

Correct Diesel Lubricants to Fit Any Condition

The cylinder walls and piston rings of a Diesel Engine are the most important points of lubrication. The oil used for this lubrication must be able to stand the most severe service and still give excellent lubrication. Nonpareil Diesel Oils meet these requirements.

Nonpareil Diesel Oils set new standards of performance. They are exceptionally clean. They form a minimum of carbon. Each of the three grades possesses all of the characteristics of superior Diesel lubricants. Graded in viscosity as they are, these oils are particularly well adapted to give vastly improved lubrication to Diesel Engines under a wide variety of conditions. When the proper grade is selected and correctly used, efficient economical lubrication in your Diesel engines is assured.

One of our lubrication engineers will be glad to give you further details regarding Nonpareil Diesel Oils and recommend the proper grade for your requirements.

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If you do not have a complete file of all lubrication monographs, write for them. Fourteen have now been published.

STANDARD OIL COMPANY (INDIANA) SERVICE

NRA MEMBER U.S. WE DO OUR PART

FAMINE IN THE LAND

Owners of large buildings in America's great cities wring their hands at real-estate operating losses, while they neglect the most obvious means of dissolving the red ink from their ledgers. Mr. Habben writes from first-hand experience. He quotes actual dollars on actual buildings.

IT SEEMS inconceivable, with practically every business, and especially real estate, holding its hands to high Heaven for relief, that there should be, if not a cure, a considerable palliative at hand.

It is even more remarkable to find that it is so difficult to persuade the patient at least to try out this plan for partial, possibly total, relief.

Probably nowhere else in the world is as much money wasted by the uneconomical generation or purchase of power as in New York City, and probably nowhere else in the world is it as difficult to interest those who are the losers by such conditions.

Strong words these to be used in connection with a city which has no near rival in the number of its huge skyscrapers, large stores, office buildings, immense hotels and vast apartment houses; a city which boasts of leading the world in efficiency and up-to-dateness.

If such conditions exist in New York, it is only reasonable to suppose that they exist to a considerable degree in all other large cities.

First of all, let us present some of the evidence which was responsible for the opening paragraphs, and then discuss the causes. Both should be of vital interest to those whose painful duty it is to meet power bills, those persistent scourges which form such a big percentage of the operating costs of large buildings.

The writer has been retained by one of the largest banking institutions in New York City to go over some of their largest holdings with a view to effecting economies in the power plants.

The evidence to be presented will be the results found in the very first four buildings investigated, to be called Buildings A, B, C, and D.

Summarized, the possible savings in these four buildings amounted to $59,697 a year. The total investment required to realize this saving is $82,014.

Inasmuch as it took less than 3 months to make these surveys, this is a saving in operating costs *at the rate of over $250,000 per year* for the first year of survey work. The investments required and savings obtainable for each item are listed in the accompanying table.

Building A is a large office building in the downtown section of Manhattan on Broadway, generating its own steam and electric power.

The plant consisted of some horizontal tandem-compound Corliss engines about 25 years old, and a 5-stage geared turbine about 5 years old.

It had been the practice to operate the turbine, and keep one, sometimes two, of the reciprocating engines shut down.

Item 1 (see table) is a very conservative estimate of the saving which could be made by running the more efficient reciprocating engine instead of the turbine.

Item 2 represents the saving which could be made by installing a larger and more efficient feed-water heater than the existing one, which was a trifle too small.

Item 3 is the saving which could be made by installing an additional closed heater, which would raise the feed-water another 20 deg. F.

Item 4 is the saving possible by installing either stokers

OF PLENTY

BY L. E. HABBEN
Mechanical and Electrical Engineer, New York City

or oil burning equipment (they worked out to be almost equally economical) in place of the present hand firing of coal.

Item 5 represents the saving made by replacing some steam-driven duplex pumps by motor-driven centrifugals.

Building B is another office building, but uptown on Broadway, which had a low-pressure heating plant and purchased electric power.

By installing a fully automatic oil-burning system under the two heating boilers, in place of the present hand-fired coal, savings as per Item 1 could be made.

Inasmuch as this building already had a low-pressure heating plant, it appeared to be a favorable prospect for an automatic diesel-electric installation, and this proved to be the case, as indicated by Item 2.

In collaboration with the manufacturers, a proposal was submitted whereby the entire installation could be paid for out of savings, and with no outlay by the owners.

Under this scheme, the payments for the equipment amounted to over $900 a year *less* than the electric power bill had been during the previous 12 months; after 6 years the building would own the plant, and from then on would save more than $11,000 a year. Item 2 gives the average saving over 10 years.

Unfortunately, considerations other than economics have temporarily held up this proposition.

Building C presented yet another and entirely different problem. District steam was purchased for heating only. Electric power was also purchased. The possible savings were not numerous, but were certainly very attractive.

This building has no smokestack, and the investment necessary to install a boiler plant and chimney does not show an attractive return. The listed saving can be effected by installing steam-electric generating sets operating on purchased steam.

After the machines have paid for themselves (in about $2\frac{2}{3}$ years) an item of $1,980 per year (interest on the investment) will disappear from the operating costs, and the annual savings will be $14,393, or about 14 per cent of the total operating costs of the building.

Building D presented practically the same problem as the preceding one, with the additional smaller savings connected with the metering of the tenants.

As pointed out by the writer in previous articles,* the vast majority of real estate owners appear to think that money spent in the power plant is money thrown away. Apparently this peculiar attitude is taken because there is no actual cash sale made, with a corresponding profit which can be seen on the cash register.

Business managers seem to think that the economies resulting from changes to, or an investment in, power-plant equipment are purely fictitious figures—possibly of academic interest to the technically minded engineer, but things to be looked at askance by the really bright executive.

For a return of from 6 per cent to 10 per cent, these same executives will invest money in stocks, bonds or some other business having none too firm a foundation, yet they will not even listen to a proposition which will pay anywhere from 30 per cent to 100 per cent with no risk to the investor.

There are many reasons why the power situation got where it has, and among them may be listed the following:

1. In the first place, it would appear that the power requirements for large buildings are by no means thoroughly understood, even by many engineers, and that these requirements are not generally given the attention their importance demands, principally because the necessary data on the subject are very scarce.

2. In the march of progress, the smaller power plants have been left practically "as was" 20 years ago, because of the owners' reluctance to invest money in something below ground, and which would not show a direct profit.

3. A few manufacturers of power-plant equipment have employed salesmen on a commission basis only, with the result that although their product may be perfectly good, apparatus has of sheer necessity been sold more with an eye to the sale than to the conditions under which it will have to work. This results in making owners very shy of "savings in the power plant" talk.

4. Owners are forcing manufacturers more and more into doing what is really consulting engineering work, in the belief that they are getting something for nothing.

THE EVIDENCE

Building	Item	Annual Saving	Investment	Months to pay out
A	1—Operate existing compound engines	$2,240.00	None	..
	2—Install new feed-water heater	950.00	2,400.00	30
	3—Add a closed heater	1,270.00	400.00	4
	4—Install stokers or oil burners	19,332.00	18,500.00	11
	5—Install motor-driven centrifugal pumps	2,050.00	2,500.00	14½
	Total, Bldg. A	$25,842.00	$23,800.00	11
B	1—Install automatic oil-burning system	1,190.00	3,438.00	35
	2—Install automatic diesel (see text)	5,900.00	None	..
	Total, Bldg. B	7,090.00	3,438.00	6
C	1—Install engine to operate on purchased steam	12,413.00	33,000.00	32
	Total, Bldg. C	12,413.00	33,000.00	32
D	1—	10,550.00	21,000.00	24
	2—	1,752.00	776.00	5½
	3—	2,050.00	None	..
	Total, Bldg. D	14,352.00	21,776.00	18
	Total of 4 buildings	59,697.00	82,014.00	16½

*Power, April 12, 1932, June 14, 1932.

The manufacturer is in no way to blame, for if he refuses he stands no chance to make a sale. No one is better qualified than the manufacturer to state just what his equipment will do, but, after all, he is in business to sell his apparatus. If a manufacturer of steam engines is asked for a price on a steam-electric set, he is not going to recommend say, a diesel-electric unit, even if he should know that a diesel set would be a more profitable investment for that particular service.

This practice has resulted in some plants being installed where, although they may show a good saving, an even more economical scheme could have been evolved by a strictly impartial investigator.

Can these conditions be improved? The answer is important to everybody, because an improvement in power generation and application would undoubtedly mean the placing of very large orders with the manufacturers of power-plant equipment and the employing of thousands of men to produce this equipment, while an untold number of businesses, buildings, and institutions would be writing their balances in black instead of red.

The answer is, of course, an intensive campaign of education by the technical press, the daily press and by the manufacturers of power-plant apparatus.

This campaign of educating the non-technical executive must take the form of every-day language, devoid of all such expressions as "B.t.u. per hour," "pounds of steam per kw.-hr.," etc., so beloved by the technical man.

Present conditions concerning large buildings, which the writer has made his particular study during the past two years, are approximately as follows:

Possibly more than half the large properties in New York City are in the hands of receivers, or are well on the way there, and eventually most of these buildings are taken over by banks and insurance companies which have invested heavily in first mortgages.

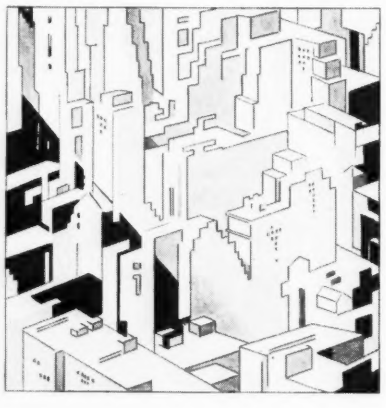
A suggestion to bring an old, dirty, inefficient plant up-to-date, is invariably met with the exceedingly stupid reply that, "We don't want to throw good money after bad, we want to sell those buildings as soon as possible, as we are not in the real estate business."

If the operating expenses of a building can be cut 14 per cent by revamping its power plant, as indicated in one of the examples given, it is surely elementary economics to point out that there is a far better chance of selling that building.

The excuse so often heard that money cannot be obtained for a gilt-edged investment yielding from 33 per cent to 50 per cent indicates one of three things: the bankers from whom the money must be borrowed are the most inept of business men; there must be some political and uneconomic factor governing the case; the project is not properly understood by the owner.

The writer finds it hard to believe that New York executives are so hopelessly incompetent as to refuse money for purposes which will bring in such returns, unless one of these reasons applies. He defies anyone to name a better investment.

Possibly there are a few cases where legal restrictions prohibit the borrowing of money on certain properties or under certain conditions, but it is believed that these cases are in the great minority.



The executive who started the writer upon his investigations is one of the few far-sighted enough to see things in their true perspective. His reaction to a question from the writer was, "Certainly, we want to sell these buildings, but we are not going to fool ourselves, we shall probably have to hold them for 3 years, 5 years or even longer, so in the meanwhile let us put them in the best possible condition, and obtain the benefits to be had; they will also be more attractive to a possible buyer in the future."

This subject is by no means the simple one it has been considered up to the present; a very wide field must be surveyed before it can be said that the best solution has been found for a particular building.

First of all one must be able to predict, with fair accuracy, how the steam and electric loads in a particular building will vary from hour to hour, and must be equally familiar with steam and electrical problems, heating systems, etc.

The question of purchasing or generating power must be decided, which in turn requires a knowledge of steam and electric rates and contracts. The cost and performance of steam-electric and diesel-electric sets must be known, also the advantages and disadvantages of high-pressure and low-pressure steam plants.

Often a combination of generated and purchased power works out to be the most economical, and then a decision as to how much should be generated and how much purchased must be made. Possibly no other branch of engineering presents such a wide and interesting field as that of power and heat supply for large buildings. Certainly no other offers greater sources of new revenue for the harassed industry, business or institution.

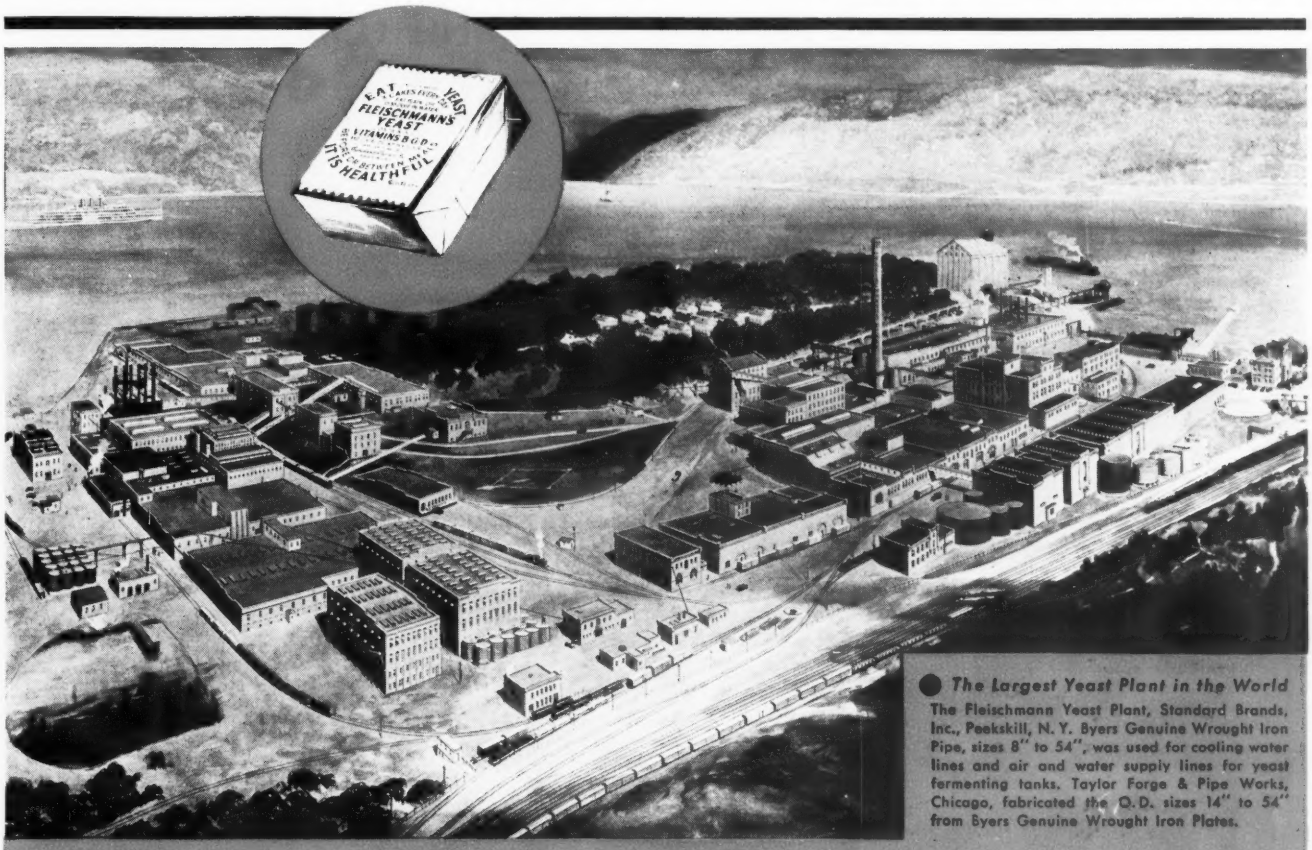
The various combinations which may prove to be the best for any one particular condition are too numerous to mention. A few examples, but not all, are listed.

1. Purchase H.P. steam and purchase electricity.
2. Purchase H.P. steam and generate electricity (steam-electric).
3. Purchase H.P. steam and generate electricity (diesel-electric).
4. Purchase H.P. steam and generate electricity (steam-electric), also buy some electricity.
5. Generate H.P. steam and generate electricity (steam-electric).
6. Generate L.P. steam and purchase electricity.
7. Generate L.P. steam and generate electricity (diesel-electric).
8. Generate L.P. steam and generate electricity (diesel-electric), also buy some electricity.

When it is remembered that, in addition to the above combinations of buying and generating power, there is a growing tendency to use both diesel-electric and steam-electric sets, the one being used for a standby for the other, it will be appreciated that the subject is too complex for an off-hand solution.

The fact remains, nevertheless, that all needed data for the correct power analysis of any building are obtainable. If any building owner overlooks this possibility of turning operating losses into profits he has only himself to blame.

CALL THE ROLL of American Industries



The Largest Yeast Plant in the World
The Fleischmann Yeast Plant, Standard Brands, Inc., Peekskill, N. Y. Byers Genuine Wrought Iron Pipe, sizes 8" to 54", was used for cooling water lines and air and water supply lines for yeast fermenting tanks. Taylor Forge & Pipe Works, Chicago, fabricated the O.D. sizes 14" to 54" from Byers Genuine Wrought Iron Plates.

Fleischmann's Yeast Plant uses BYERS WROUGHT IRON for tough services

IN every industry there are tough services where more than ordinary consideration must be given to material selection. Such is the case in the Standard Brands Fleischmann's Yeast Plant at Peekskill, N. Y.

Tremendous volumes of water and air must be handled in the fermenting process. Byers Genuine Wrought Iron was selected on its record of long, economical service.

For tough services, whether water, heating, refrigerating or process piping, or tanks, smokestacks, roofing and siding, Byers Wrought Iron is held in high regard by leading plant engineers coast-to-coast.

What about the tough services in your plant? May we work with you in studying conditions and reviewing some of wrought iron's records in corrosive service?

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ALIGNMENT CHART FOR SELECTING FLAT BELTS

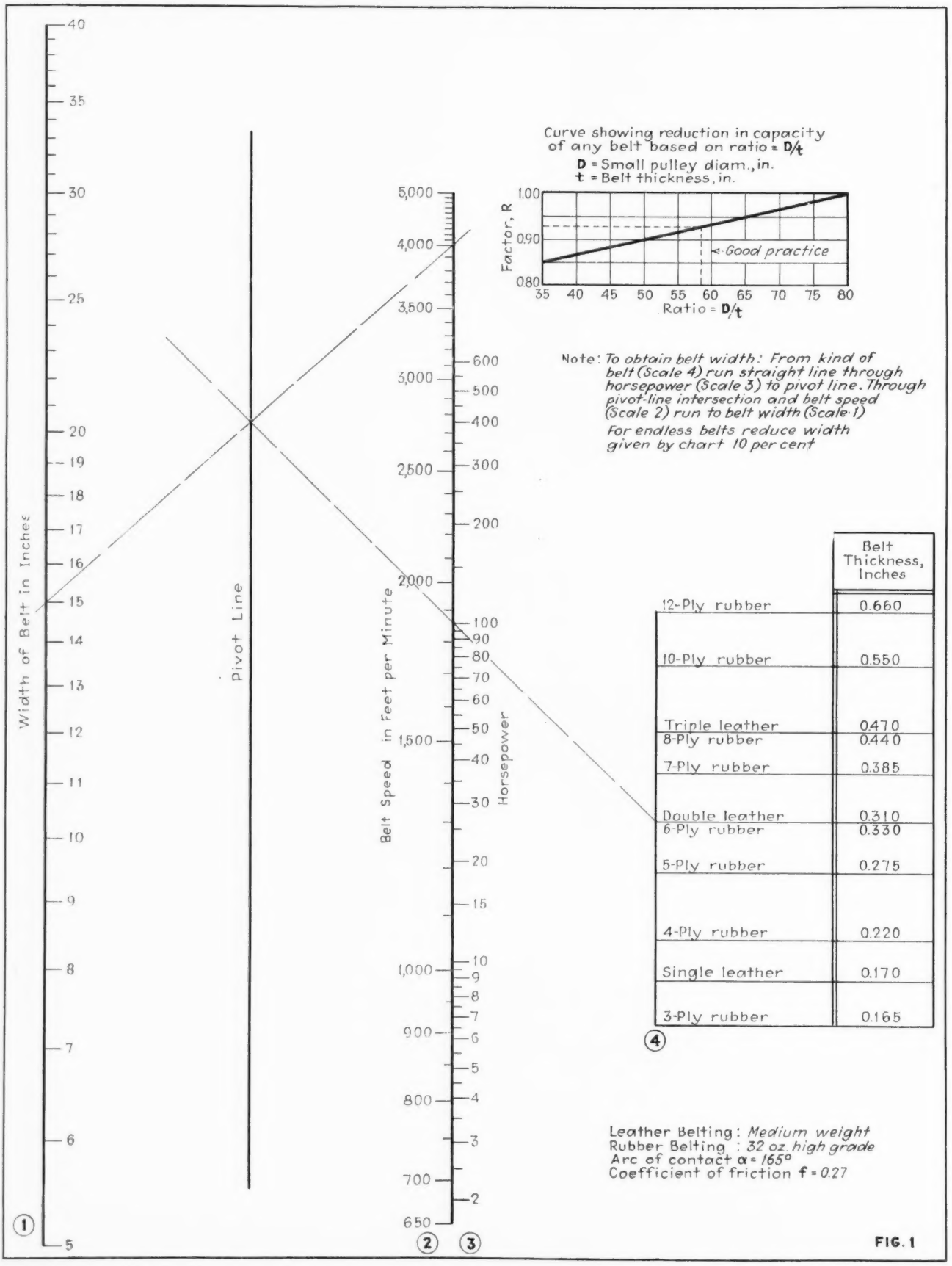


FIG. 1

By E. Cowan, Industrial Engineer

© POWER

ALIGNMENT CHARTS SOLVE

FLAT BELT PROBLEMS

By E. COWAN
Industrial Engineer
New York City

MANY factors influence the choice of the correct flat belt for a given drive. These include: type of machine to be driven, size of pulleys, belt speed, local conditions. The charts on the facing page and in this article have been designed to simplify belt selection and at the same time take into consideration the essential service factors. These charts represent many years' study of belt applications in several large industrial plants. They give belt sizes that have been found to be economical, giving long service with low maintenance costs.

It will be found that the primary chart, Fig. 1, covers a range including the large majority of medium-size and large belt installations. It is designed for oak-tanned leather and good-grade friction rubber belts working on cast-iron or steel pulleys with an arc of contact of 165 deg. on the smallest pulley. Belts will carry loads in excess of that allowed in the chart, but only with an increased tension, which means increased friction loss in bearings and a shorter life for the belt.

How Chart Is Used

To illustrate the use of the chart, Fig. 1, assume a coal conveyor driven by a 50-hp., 850-r.p.m., wound-rotor induction motor. Conditions under which the conveyor may have to be started will require the motor to develop 250 per cent starting torque. Then, the belt will have to be designed for double the rating of the motor, or for 100 hp., as indicated by the Service Factor Table. For a 50-hp., 850-r.p.m. motor, the standard-size pulley is 13 in. diameter. This will give a belt speed of about 2,900 ft. per min. Because of the large increase in power that the belt is being designed for, as compared to the motor rating, it will be better practice to select a belt speed of about 4,000 ft. per min. or higher, in order to obtain good belt proportions. An 18-in. pulley will give a speed of 4,000 ft. per min., which is an economical value.

Assume that a ratio of 1 to 2.5 is required from the motor to the driven pulley. Then the minimum center distance should be not less than 14 ft., as obtained from Table I. Further, assume that the motor is to have a paper pulley and that the driven one is steel. For a trial, select a double-leather belt. This is 0.31 in. thick as obtained from the chart, Fig. 1. The ratio of pulley diameter to belt thickness is $\frac{D}{t} = \frac{18}{0.31} = 58$. This value is within the range of good practice as indicated on the small chart, Fig. 1.

To determine the width of belt, on the chart, Fig. 1,

Service Factors by Which Motor Horsepower Must Be Increased When Selecting Belts

Kind of Load	*Service Factor*
Starting load light, operating load normal	1
Pulsating loads, starting peaks 150 per cent normal	1.40
Shock loads, starting peaks 200 per cent normal	1.75
Heavy starting and peak loads, 250 to 300 per cent normal	2
For across-the-line start alternating-current motors, never less than	2

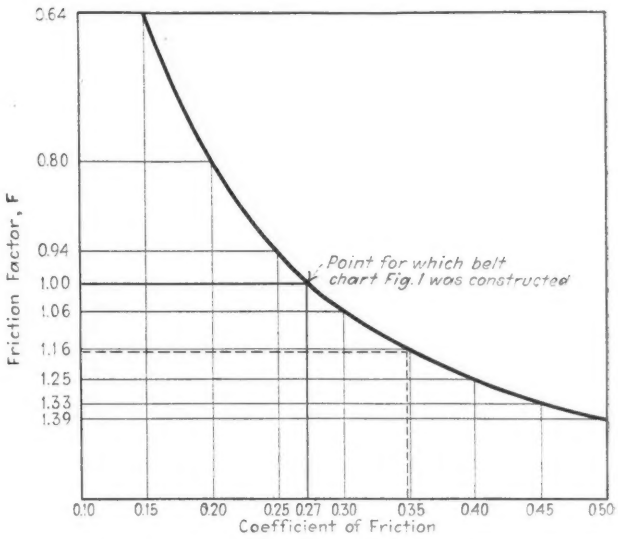


Fig. 2—Coefficient-of-friction correction factors

TABLE I - MINIMUM DISTANCE BETWEEN PULLEY CENTERS, FT.

Pulley Ratios	Motor Horsepower to be transmitted										
	1-4	5-9	10-14	15-24	25-39	40-49	50-74	75-99	100-124	125-149	150-200
1-2	4	6	8	9	9	10	12	13	18	22	26
1-3	6	8	10	11	11	12	13	14	20	24	28
1-4	8	10	12	12	13	14	15	16	22	26	30
1-5	10	12	14	14	15	16	17	18	24	28	32

TABLE II - FRICTION COEFFICIENTS FOR BELTS ON PULLEYS

Kind of Belt	Cast Iron or Steel	Wood	Paper	Lagged	
				Rubber	Leather
Leather, oak tanned	*0.27	0.32	0.35	0.40	0.40
Leather, mineral tanned	0.35	0.40	0.45	0.50	0.50
Rubber, friction	*0.27	0.32	0.35	0.40	0.40
Balata	0.27	0.32	0.35	0.40	0.40
Camel hair, woven	0.35	0.40	0.45	0.50	0.50

** Value used in Chart, Fig. 1*

TABLE III - PREFERRED COMMERCIAL WIDTHS OF BELTS

Kind	Widths, Inches
Leather	1-1½-2-2½-3-3½-4-5-6-8-10-12-14-16-18-20----to 42 inches
Rubber	1-1½-2-2½-3-3½-4-5-6-8-10-12-14-16-18-20----to 42 inches

TABLE IV - RECOMMENDED WIDTHS, RUBBER BELTING

Plys	3-4	4-5	5-6	6-8
Width, inches	2-4	5-12	14-24	26-42

TABLE V - RECOMMENDED WIDTHS, LEATHER BELTING

Thickness	Medium Single	Medium Double	Medium Triple
Width in Inches	2-8	9-24	25-42

TABLE VI - RELATION OF BELT TO PULLEY WIDTH

Minimum belt width, inches	2-5 incl.	5-12 incl.	12-24 incl.	24-36 incl.
Additional pulley width, in.	½	¾	1	1½

join the point marked "double leather" and "6-ply rubber" on Scale 4 to horsepower 100 on Scale 3. This line intersects the pivot line as indicated. Through this intersection of the pivot line and point "speed 4,000" draw a line to meet the belt-width scale. This gives a belt width of 15 in.

Certain correction factors should be applied to the belt width. One of these is based on the ratio $\frac{D}{t}$, which in this case is 58 and the correction factor $R = 0.93$, as obtained from the small chart, Fig. 1. The belt capacity obtained from the chart is for cast-iron or steel pulleys. From Table II we find that, with an oak-tanned leather or a rubber belt on a paper pulley, the coefficient of friction is 0.35. The curve, Fig. 2, gives the friction factor, F, for a coefficient of friction of 0.35, as 1.16.

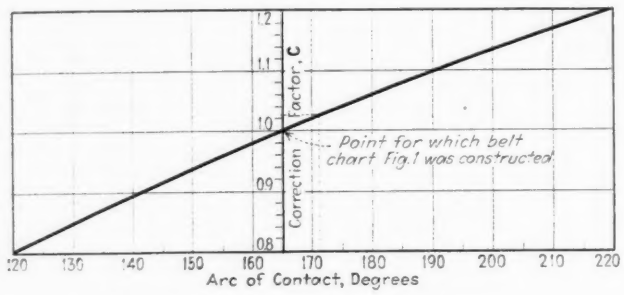


Fig. 3—Arc-of-contact correction factors

From the chart, Fig. 4, the arc of belt contact on the smaller pulley can be read off directly. The difference in pulley diameters is $D - d = 45 - 18 = 27$ in., and the center distance is 14 ft. From the center distance, 14 ft., on the right-hand scale, Fig. 4, run a line through 27 in. on the center scale to intersect the arc-of-contact scale. Read 171 deg., as indicated. The belt was designed for 165 deg. arc of contact. From Fig. 3 a correction factor C of 1.02 is obtained.

Then the actual belt width required is equal to:

$$\frac{15}{R \times F \times C} = \frac{15}{0.93 \times 1.16 \times 1.02} = 13.5 \text{ in.}$$

A 13-in. medium double-leather or a 6-ply rubber belt would probably do the job, but it will be best to select a 14 in., because this is a commercial width and a little more belt is generally better than a little less.

Since the steel pulley has a lower coefficient of friction than the paper pulley, it will be well to check the width of belt on this pulley. The coefficient of friction factor is 1, since the chart, Fig. 1, is based on steel or a cast-iron pulley. The arc of contact is $360 - 171 = 189$ deg., and correction factor C from Fig. 3 is 1.09. The ratio $\frac{D}{t} = \frac{45}{0.31} = 145$. From the small chart, Fig. 1, it is seen that for all values of $\frac{D}{t}$ above 80 the correction factor is taken as 1. Then the width of belt required is $\frac{15}{1 \times 1.09 \times 1} = 13.7$ in., so that a 14-in. belt of medium double-leather or 6-ply rubber, will be ample.

As indicated on the chart, Fig. 1, if the belt is always to be operated endless, its width can be reduced 10 per cent. In this case, a 12-in. belt would take care of the job. Frequently, when belts are installed endless, they are cut, when it is necessary to shorten them, and their ends are joined by some form of fastener. If there is a possibility of this being done, then the 14-in. belt should be used.

It is desirable to standardize the belts in a plant to as few widths and plies as possible and keep within the limits of good design. By the use of the charts it will not be a difficult job to check all the drives in a plant and then group them to reduce to a minimum the number of belt sizes actually required.

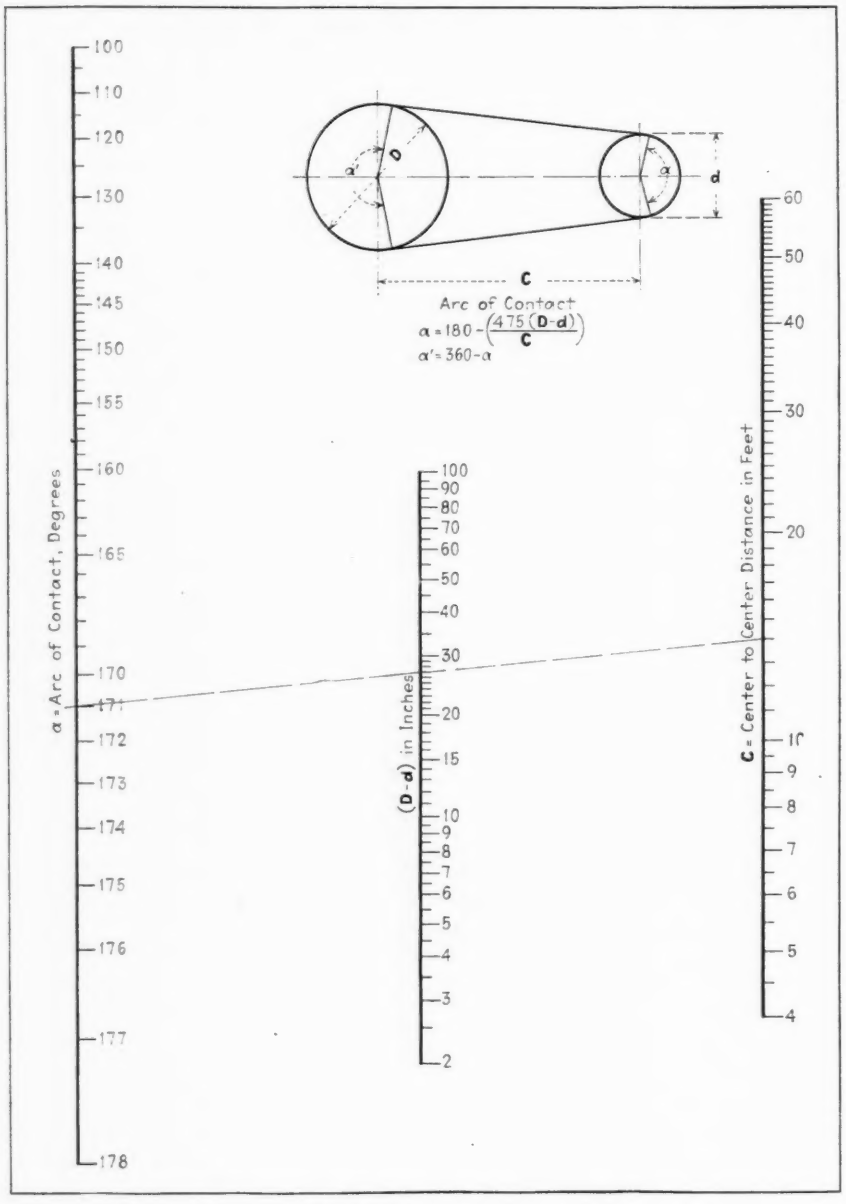


Fig. 4—Alignment chart for arc of contact of belts on pulleys

PRACTICAL AIDS TO OPERATION

An Emergency Stroboscope Determines Motor Speed

RECENTLY it was necessary to determine the approximate speed of a small series motor. When driving its normal load, it was impossible to take the speed with a revolution counter or tachometer, as the additional load slowed down the motor appreciably. To take the speed a small variable resistance was connected in series with the motor, and a black-fiber disk, $1\frac{1}{4}$ in. in diameter, was fastened to the end of the motor shaft and one white chalk mark placed upon it as in Fig. 1.

The motor was then put in normal operation and the disk illuminated by a one-watt Neon glow lamp, connected to the 60-cycle lighting circuit. When first started, the markings on the disk appeared confused. The motor was speeded up slightly. Then a six-spoked wheel, revolving

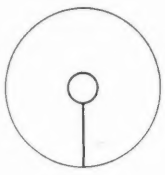


Fig.1

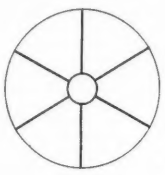


Fig.2

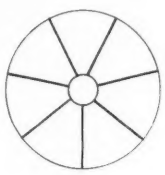


Fig.3

against rotation, appeared on the disk. Adjustment of the rheostat caused the six-spoked wheel to appear stationary, Fig. 2. Then the motor was slowed down to slightly below normal speed. Then a seven-spoked wheel appeared revolving with rotation. Manipulation of the rheostat caused the seven-spoked wheel to appear stationary, Fig. 3. This showed that the normal speed was somewhere between 7,200 alternations divided by 6 spokes or 1,200 r.p.m. and 7,200 divided by 7 spokes, or 1,028 r.p.m., which was close enough for the job in hand.

The Neon light follows the frequency of the supply circuit and, on 60 cycles, lights and darkens 7,200 times per minute, thus acting as a stroboscope when used in conjunction with the fiber disk. This method may be used to ascertain the speed of an induction motor. For example, a 60-cycle, 4-pole induction motor has a synchronous speed of 1,800 r.p.m. and when operating at normal speed with the disk on its shaft will show a four-spoked wheel slowly revolving backwards. The slip speed of the motor may be counted and subtracted from the synchronous speed, thus giving the actual speed of the motor more accurately than can be obtained with a tachometer or revolution counter and stop watch.

New Westminster, B. C. W. L. STEVENS.

Changes in Operating Methods Prevent Turbine Overspeed

ABNORMAL operating conditions may arise that take a turbine's speed control out of the range of the service governor and cause the emergency overspeed trip to function. Heading the list of abnormal conditions is sudden and entire loss of load, as when the circuit breakers open on the generator bus or the breakers on all of the outgoing lines trip out. When these disturbances can be anticipated, the turbine speed can usually be controlled within normal range by changes of operating methods. With generating stations having outside transmission lines, approaching electrical storms often give reason for expecting such trouble.

It has been found advisable in many cases to close down the throttle valve to the turbine until a slight reduction in nozzle pressure is indicated on the gage. By doing this, any sudden increase in throttle flow is partially restricted. Should the overspeed trip operate, the time required to close the throttle valve for resetting the overspeed trip is reduced.

In some plants located where severe storms are common, boiler pressure is reduced as much as 40 per cent during a storm. The reduced pressure causes the turbine to accelerate less rapidly on sudden load reduction than at full steam pressure.

With compound machines, the low-pressure unit has greater capacity than the high-pressure one. With these, procedure is similar to that followed for single-cylinder units, but in addition, the valve controlling the steam flow to the low-pressure cylinder is throttled to cause a slight pressure reduction to the first stage. In one plant this reduction is held at 10 per cent.

Throttling of the intercepting valve between the high- and low-pressure turbines also assures quick closing of this valve. With high-pressure units, allowing this valve to remain open too far will cause the storage capacity of the steam mains and reheat system to supply sufficient steam to overspeed the turbine even after the high-pressure governor has responded.

Cleveland, O. M. E. WAGNER.

Two Repairs Made on Loose Cylinder Linings

IT IS common practice to shrink and peg cylinder liners in position, but they may loosen after years of service. This loosening is due principally to heat stresses and distortion of the cylinder body. When a cylinder lining is loose, hammer-like blows will be heard as the engine crosses dead center, the intensity of the blow depending upon the amount of movement of the liner.

Proper repair for such a defect is to rebore the cylinder and fit a new liner. This is, however, rather an expensive job. Means are often employed to correct the defect, even if only temporary, until such times as a permanent repair can be made.

A successful repair was made about three years ago on a loose high-pressure cylinder liner of an 800-hp. vertical compound engine. Trouble was first noticed by steam leaks at the pegs securing the liner to the cylinder. These holes were also elongated, the pegs were loose, and a loud click was heard as the engine crank passed dead center.

After fitting several sets of increasingly larger pegs without effecting a permanent repair it was realized that a different method of securing the liner was necessary to cure the trouble. It was finally decided to remove the liner

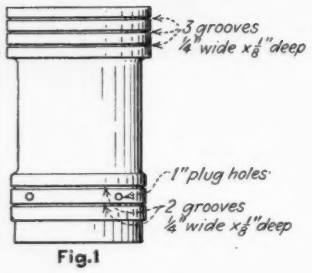


Fig. 1

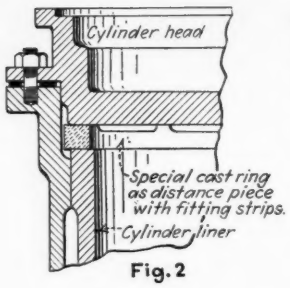


Fig. 2

for examination. It was found to be 0.023 in. smaller than the cylinder and the cylinder was 0.008 in. out of round, making a total clearance of 0.031 in. in places. The time factor in making the repair was important, so instead of reboring the cylinder and fitting a new liner, grooves were cut into the liner at each end, three in the top and two in the bottom, as in Fig. 1. These grooves were made ¼ in. wide and ⅛ in. deep, into which was hammered soft copper strip. These rings were finished in a lathe so that the copper was 0.018 to 0.02 in. above the face of the liner.

After painting the finished job with Smooth-On to insure steam-tightness and pre-heating the cylinder with steam to expand it, the liner was pulled back into position. No further trouble has been experienced, and the work was completed in two days at one-sixth the total cost of reboring and fitting a new liner.

Another case of trouble with a loose liner occurred in a similar type of engine, but this time the liner was not removed for examination before making the repair. A special ring was cast as a distance piece and placed between the top end of the liner and the underside of the cylinder cover, as in Fig. 2. This ring had strips cast on so that it could be accurately and easily held in position without throwing undue stresses on the cylinder cover flange studs, which hold the liner in position.

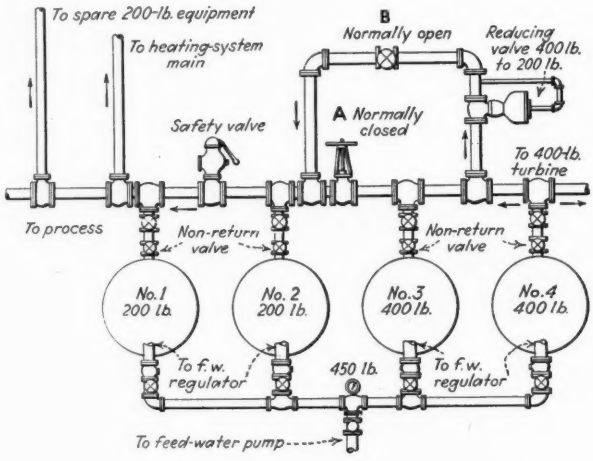
This method requires careful fitting of the ring to insure success. Although it may not be good engineering practice it may be justified where a quick repair is required. The case mentioned has been in daily use for eighteen months without giving any trouble.

Blackburn, England. J. CASSIDY.

Feed-Water Valve Leak Caused Water Hammer

IN A boiler plant, the operators recently had an unusual experience which might possibly occur in similar plants unless simple but easily neglected precautions are taken. In the figure, boilers No. 3 and 4 normally operate at 400 lb. pressure and supply a 5,000-kw. turbo-generator. These two boilers also supply steam at 200 lb. through a reducing valve to a process line. Spare 200-lb. generating equipment was available for the plant normally operated at that pressure. In case the high-pressure machine was shut down, the 200-lb. generating equipment could be operated from Nos. 1 and 2 boilers, which were connected directly into the process-steam line. Under these conditions, Nos. 3 and 4 boilers could be operated at 200 lb. under manual control to supplement the 200-lb. boilers. If this was necessary, valve *A* was opened to bypass the reducing valve. Over week ends the 200-lb. boilers supplied the heating-system.

It was the usual practice over Sundays to leave the stop valves open on the 400-lb. boilers, if no work was being done on them. The non-return valves were considered ample protection against the 200-lb. pressure from the other boilers. This worked satisfactorily for some time, until one Sunday a heavy water hammering started in the main steam header and caused a number of leaks at flange joints. The cause was found to be a slight leak through the feed-water valve on one of the high-pressure boilers which filled it up with water. The feed-water pressure was sufficient to open the non-return valve on this boiler and allow a slug of water to pass into the

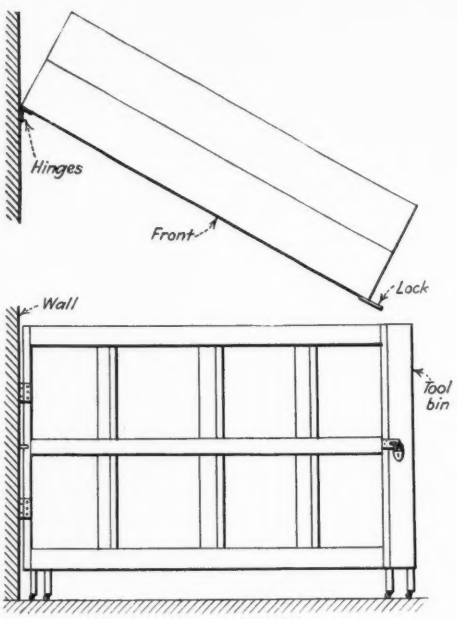


200-lb. steam line. On release of pressure in the high-pressure boiler, the non-return valve immediately slammed shut, only to open again a short time later as the pressure built up in it to open the non-return valve for another instant.

Milford, N. J. HARRY M. SPRING.

Tool Bin Locked to the Wall

A THEFT of spare parts from a tool bin used for holding miscellaneous gaskets, pipe fittings and tools in a power plant made it necessary to use a lock. To simplify the job it was decided to use the wall as a door for the bin. At one end of the front of the bin two hinges were used to attach the bin to the wall and at the other end a lock was placed and four castors inserted in the legs. With the bin locked to the wall, if anything was needed, it was only necessary to unlock it and swing it around a few feet to expose the contents.



W. H. MOORE,
Hamilton, Ont.

CURRENT COMMENT

CO_2 Machine Piping Arrangement

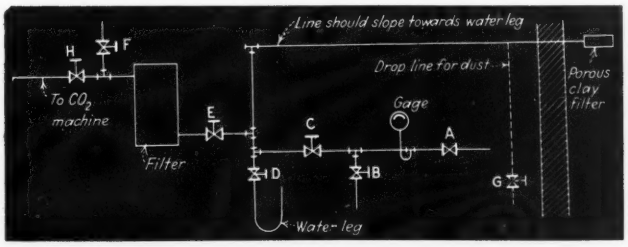
THE piping arrangement for CO_2 machines discussed by C. A. Armstrong in the August number of *Power* and also his suggestions of taking care of the line are correct in a general way but my own experience prompts me to take exception to several details.

1. For one thing, blowing the line once a week, as he recommends, is not enough in all cases. If the fuel burned is natural gas, oil, or coal under natural draft, no trouble will be experienced. But with pulverized coal, or forced-draft coal firing, the lines will get plugged up quite often unless they are blown daily. It takes only one minute to blow the line, which means 30 min. per month, but if the line is blown once a week, the 26 min. saved will be more than off-set if the line gets plugged up only once in two months. I have spent a whole day to clear a line. Another advantage in blowing the line daily is that the work becomes habitual, while if the period is weekly, the task will often be overlooked.

2. Mr. Armstrong has omitted the filter at the flue. This is very essential, as there is no end of trouble without it. A filter here may be omitted when the fuel is natural gas or perhaps oil, but with coal it is indispensable. Filters for this purpose are made of porous clay, and there are several makes on the market.

3. I am not sure that a drop line for dust collecting is necessary. I know it is recommended by most makers of CO_2 machines, but I have never used one and have never experienced any trouble on that score.

4. It is important to have a valve on the instrument side of the main filter, as shown by *F*. This valve has a



double function: (a) In testing the machine, this is a convenient place to attach the Orsat. (b) If valves *E* and *H* leak at all, when the line is blown a pressure will be built in the instrument. In blowing, valve *F* should be open.

5. Before blowing the line, valve *C* should be closed, valve *B* opened and the air or steam blown for a minute or so to remove all water.

With the exception of these five items, and in all other respects, Mr. Armstrong's treatment of the subject is ably done.

Chicago, Ill. N. T. PEF.

Bypasses Discharge to Keep Piston Pump Primed

THE device for priming pumps shown on page 379 of the July *Power* is an effective one, but I have found that a simpler means will do the job, as indicated in the

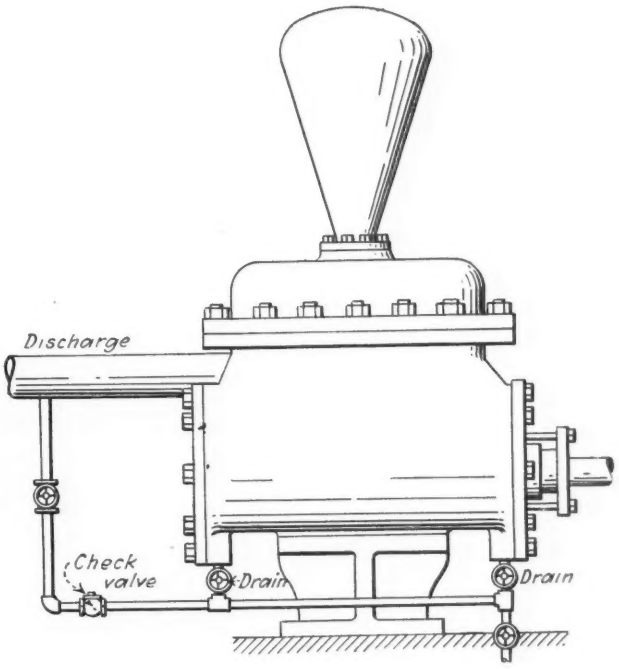


diagram. A $\frac{1}{8}$-in. pipe is connected between the discharge and the drain cocks, with a valve and a check valve, opening to the pump. This reduces the discharge by the amount of water returned through the small pipe, but this is a negligible quantity.

I had a piston pump drawing water through a 6-in. pipe 1,800 ft. long with a suction lift of 18 ft. Without the primer, it was impossible to get the pump to pick up water, and even when the suction line was filled, the pump would lose its prime. After the priming pipe was installed, it would take about 10 min. to fill the suction pipe, but after that the flow was as steady as if the water were flowing by gravity. When the suction pipe is tight, the small valve in the priming line can be closed if desired. Any loss in suction will be indicated by the pump racing, if steam driven, or a difference in sound if motor driven, after which the priming valve can be opened.

St. Louis, Mo. L. R. BAKER.

Cold Glue Used as Belt Cement

IN THE several comments on the use of fish glue for cementing belts, I agree with Mr. Hilsen and Mr. Noble that it is preferable to ordinary glue, which has to be applied hot, as it is more convenient and has a higher tensile strength. The addition of potassium chloride to the glue increases its flexibility and durability, but lowers its tensile strength slightly, as it is a deliquescent salt. By absorbing some of the water from the glue it keeps the mass from drying out to a brittle mass.

So far as this locality is concerned, glue is a back number, the leading belt makers in this city using celluloid varnish, either purchased under the name of clear lacquer from a paint store, or made by dissolving celluloid chips in acetone. Its advantages over glue are its

waterproof quality, extreme flexibility, and great tensile strength, being nearly equal to leather. Rubber cement, made by dissolving crepe rubber in high-test gasoline, is sometimes used, but I have never had satisfactory results with it.

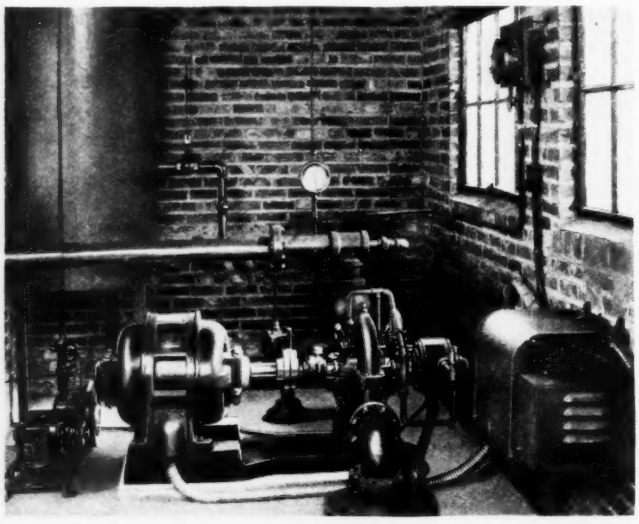
Where a belt has to be run in a steamy or damp atmosphere, and a rubber belt cannot be used to advantage, celluloid cement followed by a coat of celluloid varnish over the belt is recommended.

St. Louis. R. L. BAKER.

Automatically Primed Centrifugal Pump Supplies Sprinkler System

READING the articles in recent numbers of *Power* on priming of pumps and the wide interest prompts me to call attention to an interesting installation of a self-priming pump. The pump is used for sprinkling and general service in a large cemetery and takes water from the New York Barge Canal. It has a total suction lift of about 15 ft. and will discharge 300 g.p.m. into the underground sprinkling system against a total head of 130 ft. The installation is entirely automatic for either sprinkling or general service.

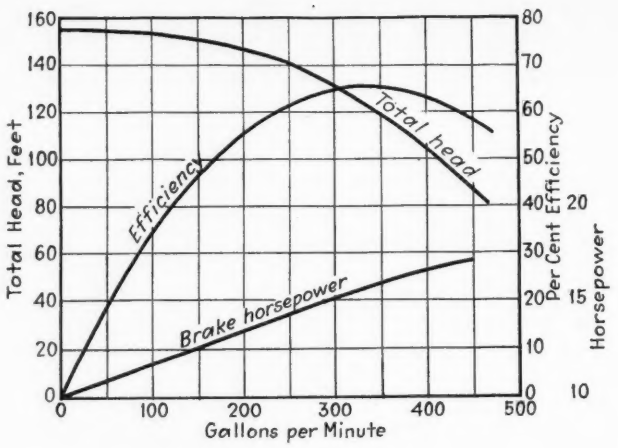
The priming unit is a hydraulic-type vacuum pump shaft mounted on an extension of the pump as shown in the photo. An emergency float switch is used to prevent the pump from starting in case the water level in the



canal is too low or the intake area becomes restricted.

The curves give the characteristics of the pump. A steep head-capacity characteristic is essential for complete automatic operation. In addition to the curve being steep, the shut-off pressure must be higher than any pressure existing when the pump is discharging, otherwise the pressure switch cannot stop the pump when all the sprinklers are shut off.

Normal shutdown condition of the system is with the starting switch in the open position and the system full of water maintained at not less than 25 lb. per sq.in. As soon as the pressure falls below 25 lb. the pressure regulator closes and starts the pumps, which continues to run until the maximum pressure is built up in the system. With this arrangement the pump starts automatically, as soon as one or more sprinklers are opened and will stop automatically as soon as they are all closed.



To supply small quantities of water when the sprinklers are not in use, a pneumatic pressure tank is installed on the system, to keep from starting and stopping the pump too frequently. This installation is an interesting example of the many conditions that may be taken care of automatically by modern self-priming pumping units.

Buffalo, N. Y. M. M. KLOSSON,
Chief Engineer,
Buffalo Pumps, Inc.

Straub on Embrittlement

DURING the last year I have received information from several sources that persistent rumors are being circulated to the effect that I have changed my opinion in regard to the cause of embrittlement in steam boilers and the use of sulphate to prevent this difficulty. One of these rumors is to the effect that a large power plant operating at a steam pressure in the neighborhood of 400 lb. maintained the 3:1 sodium sulphate-to-total alkalinity ratio as recommended by the A.S.M.E. Boiler Code Committee, and that embrittlement cracking took place. Another is to the effect that I have admitted that caustic is not one of the contributing causes of embrittlement.

It is extremely difficult to trace rumors to their source, and once a rumor is started, it spreads very rapidly. I have answered numerous inquiries in which men hearing these rumors have written to me directly. However, it becomes very difficult to stop these rumors by writing a few letters. I would like to make a public statement at this time to the effect that these rumors are not correct.

I still believe that embrittlement in boiler plate is caused by the combined action of stress and chemical attack. The stresses are inherent in the construction and operation of the boiler, while the chemical attack is caused by the presence of sodium hydroxide in the boiler water. I also believe that the presence of sodium sulphate in the boiler water tends to retard the embrittling effect of the sodium hydroxide, and if in proper proportions, will stop it entirely.

I hold this opinion due to the fact that no evidence has been presented to the contrary. If at any time such evidence is produced, I will be willing to investigate the evidence and make a public statement as to the results. I would appreciate it very much if you could publish this statement. FREDERICK G. STRAUB.

Urbana, Ill. *University of Illinois.*

Coal Selection

MR. PEF'S reply (page 467, September) to certain views expressed by me in the course of an interview printed in *Power* (May and June), presents clearly the conventional view of evaporative tests as a method of selecting coal. With this there is no quarrel from a theoretical or academic standpoint.

From a practical standpoint, however, Mr. Pef himself inserts certain provisos which are all-important. To quote, "But if the use of evaporative performance, as it is applied today, is 'dangerous,' *this is because it is misapplied,*" and again, "The evaporation, *when properly determined,* is the most essential factor in the selection of a fuel." And then, "Variables *not related to the burning quality* of the fuel must be kept constant, or their variations must be allowed for." (The italics are mine.) In other words, if evaporation is properly determined, and if the extraneous variables are eliminated or allowed for, and if the results are not misapplied, evaporative tests are very valuable as a method of selecting fuels.

Only by the introduction of these, and possibly some other reservations, can the use of evaporative tests for the primary determination of relative fuel values be defended. Because of the wide-spread misuse of rather casually determined evaporation figures, the emphasis should be on the reservations.

The fact is that in practice, the typical industrial plant does not provide the equipment, nor make the preparations, nor provide for the extraneous variables which are necessary to conduct an evaporative test in such a way that the results can be properly applied in coal selection. The experimental errors that are present but concealed, usually exceed in magnitude the variations in fuel value which are supposedly being measured.

It is because of the expense of overcoming the deficiencies indicated by Mr. Pef's own reservations, and because of the impracticability of making evaporative tests of enough different coals to be significant from a market standpoint, that fuel engineering has turned to the perfection of other methods. These include the determination of the commercial quality of coals in the laboratory, and a knowledge of the effect of the different coal characteristics on performance under given conditions, which combined with market prices make it possible to survey a much larger group of available coals, and to narrow the field down to a small number (frequently to one coal) without the delay or expense of any performance test. Thus narrowed down from a broader field, properly conducted performance tests become practicable, either to confirm the fuel-engineering forecast, or to resolve a small fringe of uncertainty among a small number of selected candidates.

Throughout the whole of Mr. Pef's reply, the word "loss" does not once appear. The energy in the fuel, which is not lost in the boiler and furnace, must of course go into the evaporation of water. Fuel-engineering, therefore, has concentrated on the identification, measurement, and control of these losses, and their causes, as a basis for coal selection and efficiency maintenance, because this approach to the problem reveals more significant facts, is in the majority of plants cheaper and quicker to apply, is less likely to error, and provides facts which are interchangeable in their application among plants.

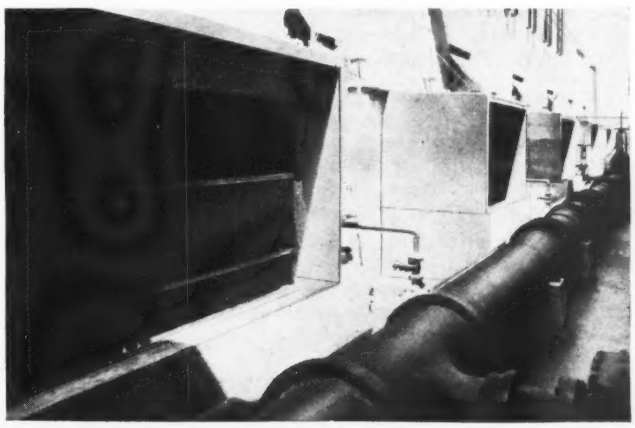
The events of the last three months give particular emphasis to the need of coal selection methods which are quickly adaptable to changing conditions. Rapidly rising fuel prices under the NRA will radically change *relative* fuel values over night. Industrial coal consumers everywhere will find it necessary to establish new values (to do it properly means a survey of the *whole* fuel market), many will find it has suddenly become profitable to change to entirely different kinds of coal, or other fuel; they will find that the safest place for previously determined figures on the value of plant modernization is the waste-basket. The operator of a steam plant under the NRA is going to have to make a completely new start, and forget many things that he has come to accept as enduring and basic. Under such conditions, there is a pressing need for the application of methods of appraisal of fuel and power-plant values which are quickly adaptable.

G. B. GOULD.
New York, N. Y.

Washed Air for Vernon Diesels

I READ with interest the article in September *Power*, "Clean the Air and Save the Machine." Your comment on the suitability of air washers for the larger jobs is interesting to us, because the new 35,000-hp. municipal diesel plant recently put into operation in Vernon, Calif., employs five Buffalo air washers, shown in the photo, for cleaning the combustion air. The capacity of each scrubber is 35,000 c.f.m.

Each unit consists of a casing of No. 16 gauge, galvanized ingot iron, inside of which are two sets of scrubbing surfaces. These scrubbing surfaces are No. 22 gauge,



galvanized, ingot-iron sheets formed to cause the air to take a tortuous path between the plates, which are spaced $1\frac{1}{8}$ in. apart. The air, thus sliced into thin sheets, has extensive contact with the wet surfaces of the plates, and all dust and dirt is removed. The second set of scrubbing surfaces includes lips or gutters for thoroughly removing entrained moisture. The power requirement for each air washer is a $1\frac{1}{2}$-hp. motor for driving the circulating-water pump for the scrubber.

The Vernon municipal station is in operation, and the advantages of using air washers for diesel engines are apparent. In addition to supplying air free from dust to the engines, the moisture content is uniform, regardless of outside atmospheric conditions. This is an important factor in diesel operation and means that compensation for fluctuation in air weight is unnecessary.

F. B. STUBINGER.
Buffalo Forge Co.
Buffalo, N. Y.

READERS' PROBLEMS

Steam-Bound Feed Pump

FEED PUMP BECOMES STEAM BOUND—*We have a turbine boiler feed-water pump that operates at 2,800 r.p.m., taking water under a 15- to 20- ft. suction head, and discharges at 175- to 180-lb. pressure. The feed-water temperature ranges from 208 to 220 deg. F. At times the pump becomes steam bound and either burns the packing or causes it to shrink away from the shaft, making repacking necessary. What causes the pump to become steam bound and what can we do to prevent it?* A.S.K.

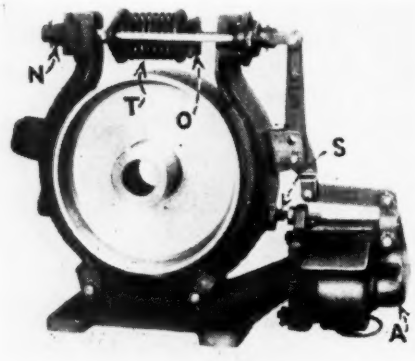
The cause of the trouble is very likely insufficient suction head at the eye of the pump. If the static suction head is from 15 to 20 ft., when the demand for feed water increases rapidly the head at the eye of the pump may fall below the vapor pressure of the water, and the pump becomes steam bound.

It may be that the connection between the pump and feed-water heater is unusually long and under size. The maximum velocity of the water in the suction line should not exceed 6 ft. per sec., preferably less. Although, if the pump is properly designed and installed, 15-ft. static suction head should be sufficient with 212-deg. F. water, it will not be adequate when the water has a temperature of 220 deg. If you happen to get a combination of high temperature and low static suction head, the pump is likely to become steam bound.

Payne Brake Adjustment

ADJUSTING AN ELEVATOR BRAKE—*With a Payne elevator brake of the type shown in the figure there appears to be no provisions made for equalizing the pressure of the shoes on the wheel. How can the brake be adjusted to insure equal pressure?* L.W.C.

When this type of brake is released, the whole mechanism is free to adjust itself to the brake wheel, consequently, the pressure of the two shoes automatically equalizes on the wheel. There are types of brakes that can be adjusted so that one shoe may be applied with greater pressure than the other, but this is not so with the Payne brake. Provisions are made in the brake, however, so that the shoes may be adjusted to lift equal distances from the wheel. Stop *S* should be so adjusted that when the right-hand shoe is against it, the shoe will just clear the brake wheel. The left-hand shoe is then adjusted by nut *N* so that it just clears the wheel when the brake is released and the right-hand shoe is against stop *S*. When releasing the brake it is necessary to do this by applying effort directly to magnet armature *A*, otherwise lost motion in the brake may lead to wrong conclusions. After the brake has been adjusted to the proper clearance, turn up on nut *O* until spring *T* gives the proper brake-shoe pressure.



QUESTIONS for Our Readers

How to Reclaim Belting

Question 1

I should like to know the experience of Power *readers with reclaimed leather belting. How much belting must be used in a plant before it pays to put in reclaiming equipment and what kind of apparatus is required? Where reclaiming is not done in the plant has it been found more economical to send old belts to the manufacturers to be reconditioned or to purchase new belting? What length of service may be expected from reclaimed belting compared with new belting operating under the same conditions?*—M.R.

Generator Operated as Motor

Question 2

We have a 100-kva., 600-r.p.m., 480-volt, alternating-current generator that we wish to use as a synchronous motor, belted to a centrifugal pump. What changes if any are necessary in the machine to make it operate as a motor? If Power *readers have had experience with alternating-current generators operated as motors, I would appreciate knowing of their success or difficulties.*—B.A.S.

Suitable answers to these questions from readers will be paid for if space is available for their publication.

Will Increased Pressure, Even if Throttled, Cause Engine Trouble?

ANSWER to September Question

THE QUESTION

SOME *time ago we installed a new uniflow engine and increased our steam pressure from 100 lb. to 160 lb. gage. When the new engine went into operation, our old four-valve Corliss engine was shut down, but not dismantled.*

Recently the load has increased so that it has become necessary to operate the Corliss engine again. The steam pressure was reduced to 100-lb. pressure by hand regulation of a valve in the line to the engine. Under these conditions the engine labored and pounded badly, although it had operated satisfactorily when last used.

We then tried operating by reducing the pressure carried on the boilers to 100-lb. pressure. Under this condition the engine operated as well as it had before the new engine was installed.

In starting the Corliss it was our practice to operate the valves by hand. With the throttled steam pressure it was almost impossible to move the valves, but when 100-lb. boiler pressure was carried the valves were easy to operate. The pressure gages were carefully checked and found correct.

I shall appreciate it if some POWER *readers can tell me what makes the engine operate so poorly on steam reduced from 160-lb. to 100-lb. pressure when it operates all right when 100-lb. boiler pressure is carried.* A.A.T.

Pressure Not Reduced to 100 Lb.

IN ATTEMPTING to reduce the steam pressure from 160 to 100 lb. by hand regulation of a throttling valve in the engine steam line, it would be impossible to maintain a continuous pressure at the engine valves of even approximately 100 lb.

During the portion of the cycle when the engine steam valves were closed, the steam pressure at the engine valves would increase, and while a steam valve was open, the steam pressure at the engine valve would decrease. This condition would exist both during operation of the engine at normal load and speed or when operating the valves by hand to start the machine.

The fact that the engine pounded badly and labored when running would indicate excessive steam pressure at the instant of intake valve opening, which pressure, upon opening of the steam valve is quickly reduced below the normal 100 lb. pressure before the point of cut-off is reached.

With the engine running at normal speed under the conditions described by A. A. T., even an accurate pressure gage might not give an accurate picture of pressure conditions at the engine steam valves, because the gage would necessarily have to be sluggish in operation to keep the needle from playing over a wide range on the

scale. And, though the gauge actually indicated approximately 100 as an average steam pressure at the engine valves, the actual instantaneous pressures probably ranged far above and below this average.

Oklahoma City, Okla. J. H. BENDER.

Temperature Increase Has No Effect on Lubrication

MR. A. A. T. has failed to advise us concerning the quality of the steam going to his engine under the two conditions. If the steam at 160 lb. gage pressure is dry and saturated it has a temperature of 371 deg. F. After throttling to 100 lb. gage pressure the steam temperature would have been 350 deg. F. This represents a superheat of about 12 deg. which may very well be the reason for the difficulty. Valves and other close clearance parts in contact with the steam are usually fitted to operate at a given temperature and an increase in temperature may cause binding. It is true that there is a difference of only 12 deg., but since this is the only change in conditions it must follow that the change in quality and temperature is the reason for the difficulty. The slight superheat in question should have little if any adverse effect on the valve and cylinder lubrication.

San Francisco, Calif. M. S. GEREND.

Increase Lubrication

THE trouble is caused by the effect of throttling from 160 lb. pressure to 100 lb. Assuming saturated steam at 160 lb., throttling to 100 lb. results in the steam at 100 lb. having approximately 12 deg. superheat. The probability is that even this small amount of superheat is sufficient to make the valves work stiffly because of the reduced clearances with the higher temperatures and also because the superheated steam supplies no moisture for lubrication. Under normal 100 lb. operation there will be enough moisture in the steam to supply lubrication for both valves and cylinder. If steam cylinder lubrication is used, increasing the amount of lubrication and if possible introducing it in the steam line at a point more remote from the engine may remedy the trouble.

LIEUT. COM. T. A. SOLBERG.

Philadelphia, Pa.

High Pressure Makes Valves Stick

THE Corliss operation trouble described by A.A.T. is most probably caused by the method used to reduce the steam pressure on the engine line. The fact that the engine runs smoothly and normally when the boiler pressure is reduced to 100 lb. shows that there is no mechanical trouble in the engine.

When reducing pressure through an orifice, or cracked valve as in this case, the rate of flow must be kept constant to get constant pressure reduction at any given setting of the valve. In this case the condition of constant flow is not realized because the volume of the pipe line between the throttled valve and the engine is not large enough to absorb the pulsations of steam admission to the engine. It is entirely possible that under full-speed full-load conditions, the steam pressure on the inlet valve at the moment of admission is about 130 lb. When the inlet valve opens, the steam passes into the cylinder faster than it can be supplied through the cracked valve, so that at the instant of cut-off the pressure is on the order of 80 lb. Since most Corliss valves are semi-floating, this high steam pressure at admission would seat them more firmly and make them hard to start in motion.

The pressure pulsations under operating conditions may be so rapid that the present gages will not register them, but this pressure trouble can be spotted by taking two indicator diagrams—one when running on throttled steam and one when running on 100 lb. boiler pressure. A sharp pressure drop during admission will most probably be shown on the throttled steam card. Another way to spot the pressure variation would be to put the indicator on the steam line to the engine, or engine steam chest, and move the paper drum by hand.

As a remedy for this trouble, the writer suggests consulting the engine builder about changing the valve gear for the higher pressure; installing a receiver between the throttling valve and the engine of two or three times the cylinder volume to absorb the pressure variations, or sectionalizing the boiler header so that part of the boilers can operate at 100 lb. to feed the Corliss engine.

J. D. MCCONNELL.

Greensboro, N. C.

Increase in Temperature Cause of Trouble

I ASSUME your engine originally operated with saturated steam generated at 100 lb. gage pressure. By generating the steam at 160 lb. pressure the temperature of the steam is increased about 32 deg. F. over that at 100 lb. pressure and is superheated about 12 deg. The result is that dry steam of appreciably higher temperature is supplied to the engine.

This can affect the engine in two and possibly three ways: First, there will be a tendency for the higher temperature to cause greater expansion of the metal, which may cause binding of valves and pistons. This, however, does not seem probable in an old engine that is doubtless more or less worn from original fits. Second, the cylinder oil may not be suitable or in sufficient quantity to properly lubricate valves and cylinder with the dry and higher temperature steam. Third, it is possible that because of the superheat in the steam there is enough less condensation to cause too high compression with valves set for saturated steam.

I once had charge of an old style Corliss engine that twisted her valve stems while in charge of my predecessor, and he never was able to explain to his own satisfaction why it happened. A moderate quantity of soda ash was used in the boilers to insure against trouble from a little cylinder oil that got in with the condensate from the heating system and drying kilns. One cold morning they slapped a heavy load on the engine directly after it was started and caused the boilers to prime enough to upset the cylinder lubrication. Right then and there I learned how hard the valves of a Corliss engine can work when they are absolutely dry. I got the engine shut down without damage, and also had the answer to the previously twisted valve stems.

Elmira, N. Y. H. L. STRONG.

Install Larger Receiver

THE trouble A.A.T. describes is probably due to too small a receiver space between the regulating valve and the engine valves which would permit the pressure to build up way above normal during the period in which the steam valves are closed and when the steam valve opens the piston receives too heavy a thrust.

I suggest a receiver space equal to 2 or 3 times the piston displacement per stroke.

You might try this out by using a valve near the boiler, selecting a time when the other engine is down, if necessary.

WALTER S. GRISCOM.

Gloucester, N. J.

How About Blowdown?

ANSWER to September Question

THE QUESTION

I HAVE *been told that blowing down a boiler through a standard hand-operated blow-down valve is more effective in removing boiler sludge than when a continuous blow-down system is used. I should like to know whether* POWER *readers' experiences indicate this to be so.* R.P.N.

Blows Down Twice a Day To Remove Sludge

THE writer in the past year has had an opportunity to judge of the comparative effectiveness of a continuous blowdown system vs. hand operation of regular blowdown valves on two 450 lb., 1,100 h.p., five drum Stirling boilers in each of which is incorporated an extra lower drum and an extra bank of tubes in the rear.

The boiler feed water is practically 100% make-up, of good quality, treated with caustic soda, sodium sulphate and sodium sulphite external to the boilers and metadisodium phosphate fed intermittently into the boiler mud drums to prevent scale formation and corrosion and inhibit caustic embrittlement. The water is fed into the lower economizer drum located to the rear of the mud drum. Both of these drums are equipped with a pair of tandem blowdown valves at each end. The continuous blowdown connection is a perforated pipe extending practically the entire length of the middle steam drum.

During the first six months of plant operation, the continuous blowdown system bled away about 1½% of the total water fed each boiler and on Sunday, the lower

economizer and boiler mud drums were blown down under pressure through the conventional valves. At the end of that period, the boilers were taken out of service and opened for inspection. Some dirt was found in every drum, but the rear steam drums and mud drums each had heavy accumulations of sludge.

For the next four months the lower two drums of each boiler were blowndown under pressure twice every 24 hours. The continuous blow down system was operated as formerly to bleed 1½% of the feed. At the end of this period one boiler was inspected and less than two quarts of dirt and sludge were found in all five drums. In fact, the boiler was as clean as when new.

The explanation of the foregoing is simple. The continuous blowdown system can control only the concentration in the boiler water and partly due to its location in the boiler and the size of the perforations in the pipe, can never remove the solid matter that accumulates as a sludge in every boiler. On the other hand, blowing down a boiler under working pressure, through the regular valves, removes the solid sludge that drops out of the water and accumulates in the lower drums. This sludge is usually composed of sand, dirt and other foreign material carried by the water into the boiler plus any precipitate that may be formed due to chemical reaction between the salts in the water and the chemicals added for treating it.

In the case of central station boilers where the percentage of make-up is low, say 5 to 10%, and the make-up is supplied by evaporators, the necessity of frequently blowing down boilers does not exist, as generally there is no chemical treatment other than that required to maintain the correct pH value. The writer knows of eight boilers in one central station that are never blown down for the 90 day operating period between boiler cleanings and inspections. W. S. JOHNSTON.

Pottsville, Pa.

Continuous Blowdown Removes Sludge

CONTINUOUS blowdown usually is more effective in the removal of boiler sludge than a standard hand operated blowdown from the boiler mud drum.

First of all it is fairly well recognized that neither method is wholly adequate for the removal of suspended matter.

It is highly desirable, in a boiler, to maintain a low concentration of suspended matter and to do this, with the ordinary water encountered, a relatively high blowdown would be necessary. Suppose for example, that the feed water carried 10 grains per gallon of potential suspended matter to the boiler and that it was desirable to maintain only 50 grains in the boiler. To do this it would be necessary to blow down 25 gallons of water for every 100 gallons evaporated, which, of course, is excessive.

In the usual boiler the mud drum is very inadequate as a settling basin for suspended matter. In the header type of boiler the mud-drum volume is exceedingly small and in the water tube boiler the velocity of water through the mud drum, causing swirls and eddies, etc. is such as efficiently to prevent the sedimentation of suspended matter.

To provide for efficient settling of suspended matter the water must be nearly quiescent. The ability of water to carry suspended matter varies with the sixth power of its velocity, so it will readly be seen that the slightest motion or circulation of the water effectively prevents the deposit of sludge.

Continuous blowdown will give slightly better results for sludge removal than intermittent hand blowdown, because the concentration, with continuous blowdown, is kept constant whereas, with hand blowdown there is an interval when the concentration builds up so that there may be localized baking of sludge on the tube surfaces.

The most efficient method for sludge removal is to provide some means for temporarily removing the boiler water from active circulation so that sedimentation can occur. An outside sedimentation tank is one means. In such a vessel the sludge may accumulate to the extent of three or four thousand grains per gallon while in the boiler itself the concentration of suspended matter may be as low as 20 grains per gallon. If an amount of boiler water equivalent to approximately 50 per cent of the feed is circulated through such a vessel and the vessel made large enough to provide the proper retention period, the actual concentration of suspended matter in the boiler will only be slightly double that of the feed water. E. F. ECKEL.

Elgin, Ill.

Sludge Must be Removed By Hand Blowdown

THE continuous blowdown carries away concentrated impure water from the boiler at a rate proportional to that of evaporation. At the same time it transfers a large proportion of this otherwise wasted heat to the feed water by means of a heat exchanger.

The standard blowdown system allows concentration to build up to a predetermined maximum value and then reduce it all at one time, incidentally wasting the heat in the water blown off. This is somewhat of a "hit or miss" system unless particular pains are taken in testing the boiler water concentration and intervals between blowdown time are not allowed to be too long.

The continuous blowdown line connects into the boiler drum just below the water level. It should therefore be understood that any sludge that settles in the mud drum after idle periods must be removed by the standard blowdown.

The continuous blowdown is not designed for this purpose but holds the concentration at a low maximum value thereby preventing much sludge from solids instead of allowing conditions favoring its accumulation and then removing it.

HARRY M. SPRING, JR.

Milford, N. J.

Use Hand Blowdown To Remove Sludge

EFFECTIVENESS of a continuous blowdown system in the removal of sludge from a boiler depends upon the extent the sludge is held in suspension in the water. The primary function of the continuous blowdown systems is the control of concentration of dissolved and suspended solids to avoid carryover with the least possible loss of heat. They are not intended to remove the sludge and mud which gravitate to the mud drum of the boiler. This material must be removed by periodical manual blowdown.

Frequency of manual blowdown will be governed by the condition of the feed water in regard to the quantity of sludge forming salts dissolved or held in suspension in it, feed water treatment used, and the type of boiler. It is desirable to remove sludge from boilers of the self contained fire box type or the horizontal return tubular type more frequently than from boilers of the water tube type in which the mud drum does not come in contact with the direct furnace heat.

Except in cases where the feed water is known to be completely softened, evaporators are used, or the percentage of raw water makeup is negligible, it is advisable to manually blowdown all types of boilers at least once each 24 hrs. regardless of the installation of a continuous blowdown system. The duration of blowdown or the quantity of water removed can best be determined by observation of the condition of the boiler when it is taken off the line.

Roanoke, Va. S. H. COLEMAN.

More Sludge Removed By Continuous Blowdown

WE HAVE a continuous blowdown system at our plant and are well pleased with its operation. We get considerable more sludge out of the continuous blowdown system than we ever did through the standard hand-operated blow-down valves. In fact, so much sludge comes out through the continuous blow-down lines that it is necessary to blowdown the flash-tank and the heat-exchanger three times in every twenty-four hours to get the proper heat transfer.

Of course, it depends on the water used, but under average conditions when a boiler is in operation the finely divided sludge is in motion. It stands to reason that very little of this material will go out through the standard blowdown valves since they are only opened probably three times in 24 hr.. whereas with a continuous blow-down system this sludge is being continuously removed. If this finely divided sludge is not removed it will form heavier and harder sludge later.

To see what effect the standard blowdown valves had in removing the sludge out of a mud drum on a Stirling boiler, we conducted the following experiment. The water was removed gradually through the manhole of the mud drum until no more would flow. The remainder of the water was removed carefully with a water pail. After almost all the water was out it was noticed that the bottom of the mud drum near the blow-down outlet for about 18 in. was free of mud. But from that point to the ends of the drum there was considerable sludge 2 to 4 in. thick. We were satisfied that little sludge was removed through the blow-down valves. Now we only operate these hand valves once in 48 hr. and then only to make sure they are in good operating condition. Shortly after the continuous blow-down system was installed one of the hand blow-down lines became plugged and it was necessary to take the boiler off the line to open up the plugged line. G. E. LINN.

Parlin, N. J.

THE ENGINEER'S BOOKSHELF

Electrical Engineering

PRINCIPLES AND PRACTICE OF ELECTRICAL ENGINEERING (FOURTH EDITION)—*By Alexander Gray, Late Professor of Electrical Engineering, Cornell University; revised by Prof. G. A. Wallace, McGill University. Published by the McGraw-Hill Book Company, Inc., 330 West 42d St., New York City. 538 pages, 6x9 in. Clothboard covers. Index and Appendix. Problems and 450 illustrations. Price $4.*

This is a complete rewriting of Alexander Gray's book, published originally in 1914 and revised in 1917 and 1924. Prof. Wallace is noted as a teacher of electrical engineering and also as a consultant, for he has been engaged in teaching and practice in this field for the past 30 years. The text is written primarily for engineering students not specializing in electrical engineering, so will serve as well as a first course in electrical engineering and as a book for the practical engineer who wishes to gain an elementary knowledge of the field. In no sense is the book merely a revision for only about 50 per cent of the new book has been retained from the old, the remainder representing progress in the field and in methods of instruction during the past ten years. Unlike many revised old texts, all illustrations depicting apparatus show modern units, and descriptions are thoroughly up-to-date in every respect.

Water-Tube Boilers

DAMPFKRAFT (STEAM POWER) (1933)—*By Dr.-Ing. Friedrick Münzinger. Published by Julius Springer, Berlin, Germany. 348 pages, 566 illustrations. 20 charts in pocket price 40 R.M.*

That this book is the work of a specialist in power plant design and construction, long associated with the eminent Georg Klingenberg, is testimony to its being authoritative. Abundance of technical detail has not been permitted to obscure the broad economic view that must dominate any successful engineering project. The chief subject is indicated in the subtitle, "Computation and Construction of Water-Tube Boilers and Their Place in the Generation of Energy." The author contends that boiler design can no longer be considered apart from associated elements, and the attention he therefore gives to the interrelations justifies the subtitle. In support of the emphasis he quotes Klingenberg that the boiler installation is the most difficult part of a power plant. In all this, however, the reader is reminded that the excellence and elegance of a form of construction do not determine its vitality, and undue emphasis on high thermal efficiency is bound to lead to biased opinions and conclusions.

Necessarily, much of the material relates definitely to public utility power plants. The book also embraces a thoroughly revised second edition of "Computations and Performance of Water-Tube Boilers." American, English and German installations are considered. Combustion processes, computation of draft losses, water circulation, properties of steel for boilers and most expedient modes of energy accumulation include new data. Several problems discuss most desirable methods of power generation. A good bibliography is included.

I-C Engines

INTERNAL-COMBUSTION ENGINES, THEORY, ANALYSIS AND DESIGN (FOURTH EDITION)—*By the late Robert L. Streeter and Lester C. Lighty, associate professor of mechanical engineering, Yale University. Published by the McGraw-Hill Book Co., Inc., 330 West 42nd St., New York City. 539 pages, 6x9 in. Indexed, 326 illustrations. Clothboard covers. Price $4.50.*

Although the present edition follows the same general form as the earlier ones, it has been brought up to date and much new material has been added. Difficult sections in chemical equilibrium have been simplified, many parts of the chapter on combustion have been eliminated and more material added to make the treatment more complete, a new chapter has been added on combustion chamber design; there is a more complete treatment of fuel injection, and a new section on knock-testing.

This is rather strictly a treatise on design, the latest revision being planned to tie together theory, analysis and design without any more use of descriptive material than is absolutely necessary. It was felt that descriptive material becomes out of date so quickly that it is of little permanent value in a text of this sort. For the man looking for design data, including even such modern design factors as flame travel, flame-front areas, combustion-chamber design, synchronous vibrations and heat flow, this is the book. Problems are included for checking and classroom.

Steam Cost

FUEL VALUEGRAPH (FOR RAPID CALCULATION OF RELATIVE FUEL VALUES AND THE FUEL COST OF STEAM—*Published by Fuel Engineering Company of New York, 116 East 18th St., New York City. 6-page instruction book and pad of 25 graphs for $1.*

These nomographic charts are used to compare the cost of steam, or the values of fuels of differing heat values, at the same or different efficiencies. The 8½x11-in. sheets contain scales for cost (either of coal or oil), total cost, coal consumption or oil consumption, B.t.u. per lb, or per gal. and combined efficiency, together with necessary transfer lines. Fuel problems may thus be quickly solved graphically.

BRIEF REVIEWS

FABRICATION OF OXWELDED PIPING. *160 pages, 6x9 in. Paper covers. Published by Linde Air Products Company, 30 East 42d St., New York City. Free*—Data on layout, maintenance and other pertinent subjects, with 75 illustrations and 20 ready-reference tables. Also data on testing and qualifying welders, inspection methods, joint testing, estimating costs.

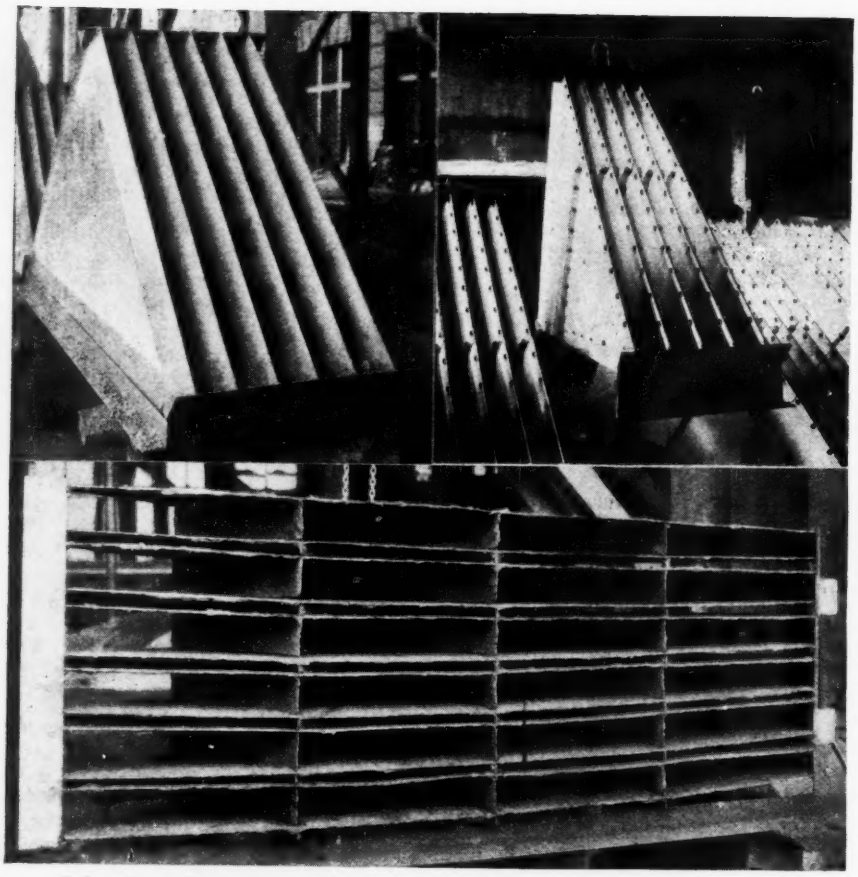
THE OLDER EMPLOYEE IN INDUSTRY. *A report of the Policyholders Service Bureau, Metropolitan Life Insurance Co., 1 Madison Ave., New York City. 28 pages, 8x11 in.*—Presents findings of a survey of 5,000 manufacturers and summarizes plans and ideas of about 800. Two charts. Free.

CARE OF LEATHER BELTS. *Being distributed by E. F. Houghton & Co., 240 W. Sommerset St., Philadelphia, Pa. 24x36-in. wall chart*—Shows how and when to dress belting, belt fastenings, how to lace a belt, how to put on a belt, tables showing width of belt for any drive, mechanical rules for figuring speeds pulley ratios, etc.

DECHEMA (GERMAN ASSOCIATION OF MAKERS OF CHEMICAL APPARATUS) REPORT for 1932. *8 pages review years work, give data on standardization and work to pull out of depressed industrial situation, and preliminary report of Chemical Engineering Exhibition to be held in Cologne May 18-27, 1934*—Also indexes standardization of chemical apparatus leaflets. Dechema, Hauptgeschäftstelle Seelze b. Hannover, Germany.

EDISON ELECTRIC INSTITUTE COMMITTEE REPORTS. *Transferred to EEI by NELA*—First three off press include A4, "Burning of Liquid and Gaseous Fuels," A5 "Power Station Chemistry," and A9 "A.-C. Network Operation, 1931." First includes data on rates of furnace heat liberation, excess air, gas metering, comparison of solid-fuel furnaces after conversion to oil or gas, gas and oil-fired furnace operation compared, deterioration of fuel oil in storage, automatic combustion control, explosions in settings and breechings, time for firing cold boilers. The second considers methods of water analysis, slag accumulation in boiler furnaces, electrolytic prevention of scale and corrosion in boilers, chlorination of circulating water, phosphate for boiler-water treatment. Prices for the three are, respectively, $0.30, $0.40 and $0.20 to members. Also A3 "Turbines," A2 "Station Piping," A6 "Pulverized Fuel," A7 "Stoker Equipment and Furnaces." EEI, 420 Lexington Ave., New York City.

BULLETIN OF THE NATIONAL RESEARCH COUNCIL. No. 91. INDUSTRIAL RESEARCH LABORATORIES OF THE UNITED STATES, INCLUDING CONSULTING RESEARCH LABORATORIES. *Fifth Edition. Compiled by Clarence J. West and Callie Hull. Price $2*—Information regarding 1,575 industrial and consulting laboratories; does not include government or institutional laboratories. Published by the National Research Council of National Academy of Sciences, 2101 Constitution Ave., Washington, D. C.



Inlet view of triangular catcher plates (left). Assembling the sections of white enameled plates to form the cinder catcher (right). View of the test set from below

HUDSON AVENUE STATION CINDER CATCHER

By GEORGE C. COOK*

Assistant to Engineer of Steam Operation, Brooklyn Edison Company, Inc.

PUBLIC interest in the reduction of air pollution in densely populated sections is steadily increasing. Utilities are making an effort to assist in this movement by obtaining better control over fly-ash emission. Attention has been largely directed to this problem as resulting from pulverized-fuel burning, but it should be recognized that with modern stoker practice the problem is equally serious.

An interesting evolution in cinder-catching equipment has taken place in the Hudson Avenue Station of Brooklyn Edison Co. (*Power*, May 31, 1932). All of the 32 boilers are equipped with underfeed stokers burning Eastern bituminous coal. The initial installation consists of twelve boilers operating with natural draft and having a maximum coal-burning rate of 53 lb. per sq.ft. of projected grate area, but under normal operation rarely exceeding 35. Each boiler was equipped with a cinder catcher of the wet type, in which gas, in the form of a wide and fairly thick column, passes under a vertical baffle hung above a body of water. This catcher has proven fairly efficient in the service for which it was designed.

The next installation consisted of eight boilers of larger size, equipped with induced-draft fans and underfeed stokers designed for much higher coal-burning rates. Due to space limitations, the cinder catcher already in use was not applicable, and a dry-type catcher was used of the type in which the cinders are trapped out of the gas stream by centrifugal action. Subsequent tests showed that these catchers did not give the degree of cinder elimination that had been expected, and in the case of the last four of the eight boilers, where high-speed induced draft fans were used, the wear upon the fans from the abrasive action of the cinders was excessive and resulted in high maintenance charges and frequent outage.

When plans were begun for the next four boilers, the requirements demanded in cinder catchers were specified as a high degree of cinder elimination and ability to clean the large volume of gas produced by the boiler at maximum rating without exceeding the space or draft loss limitations.

Satisfactory results over a period of years with the wet-type catcher had created a sentiment in favor of it. The efficiency of this catcher will fall off rapidly, however, as the distance between the edge of the baffle and water surface is increased, since cinder particles have a greater distance to fall through the gas stream before reaching the surface of the water. The weight of gas to be cleaned on the new installation was 2½ times that for the original boilers. To handle this increased quantity of gas, while still retaining the same baffle height, would necessitate extending the length of the catcher 2½ times, which would be impossible in the space available.

The other alternative would be to increase the baffle height 2½ times, which would lower the efficiency below a satisfactory level. The idea was advanced that if the gas stream of the cinder catcher was made very thin on the turning radius around the baffle, and relatively wide, that by placing a number of such streams in parallel, with outlet spaces between, an efficient catcher of high capacity would result. This thought was amplified to embody the idea of each of the streams being confined between two baffles and dividing at their lower edges, half of the gas passing around one baffle and half around the other, thus producing still thinner streams at the turn. This would obviously be impossible to accomplish if the baffles extended in a longitudinal direction, but could be easily done by placing the baffles in vertical planes parallel to the flow of gas in the inlet duct. Some crude experiments made along this line showed that these ideas were sound.

A preliminary design of cinder catcher employing these principles was made to fit the space available for the new installation. It consisted of a horizontally disposed tank of rectangular section partially filled with water and covered by a distributing device. The distributing device consisted of pairs of plates of substantially triangular shape set in vertical planes and their lower edges bridging the top of the tank, each pair of plates being designated as an element. The space within each element was open to the inlet gas duct and to the space inside the tank, and was made very narrow. The space between elements was wider and open both to the space within the tank and to the outlet gas duct. Guide vanes were placed in both inlet and outlet passages to assist in obtaining uniform gas distribution.

The theory was that a series of high-velocity narrow parallel gas streams would impinge upon the surface of the water in the tank, then suffer a change of direction and a lowering of velocity before entering the outlet gas duct, thus

*Abstracted from a paper, "The Development of a New Type Cinder Catcher for the Hudson Avenue Station" which was awarded third prize in the 1933 McGraw Prize Competition of the Edison Electric Institute.

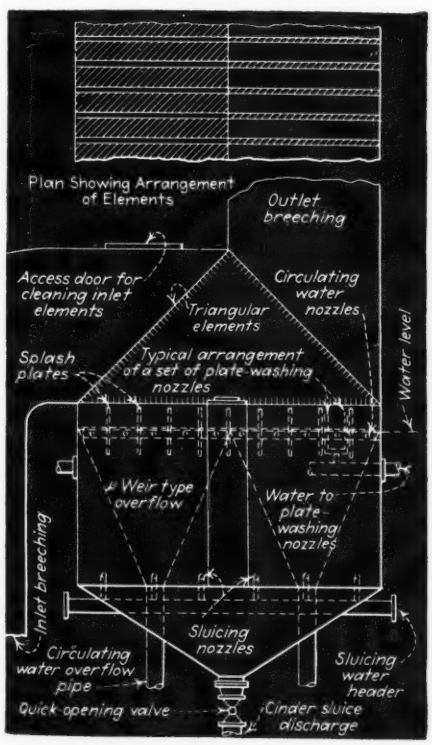
obtaining three distinct cinder-eliminating effects; impingement on water at high velocity, change of direction, and lowered velocity.

This type was found suitable only for very low gas flows, since with high flows a violent surge was set up in the water in the tank, which caused a heavy spray to be carried up into the outlet duct. To overcome the surge, a series of "splash plates" were added, set vertically in the hopper in planes at right angles to the plane of the elements at 6-in. intervals, and extending from the bottom of the elements down into the water in the tank.

It was also found that the distance between the bottom of the elements and the surface of the water should vary directly with the mass flow of gas in a straight-line relationship, and that when the level was carried in this way the draft loss was also a straight-line function of the mass flow of gas. The path taken by the gas was in the form of a loop, and the splash plates above the water line presented a wetted surface. This action undoubtedly exerted a marked influence in obtaining high efficiency. It was realized that the use of salt water would, in combination with sulphur compounds from the flue gases, give rise to corrosion problems. Experiments over a 3-month period showed that the zone of active corrosion extended from the surface of the water to 4 or 6 in. above the bottom of the elements. It was also found that the best material for the elements was steel coated on the outlet sides with an acid-resistant vitreous enamel, which also extended around the bottom edges and up 6 in. into the inlets.

Welding plates previously covered with vitreous enamel was found to present no difficulty. Caught cinders are sluiced down into the trench carrying the stoker ash at the basement level, and from this point are taken care of by the regular station ash-handling system. By a suitable arrangement of high-pressure flushing nozzles in the bottom of the hopper, cinders can be "fluidified," and flow through a piping system without clogging.

Cross-section of cinder catcher, showing arrangement of nozzles for cleaning plates, skimming water surface and sluicing cinders



The catcher as built consisted of a cast iron hopper water-proofed inside and lined with brick to a depth of a foot from the top. The hoppers were provided with steel splash plates coated with stack lining, supported on cast iron beams and held vertical by cast iron spacer pieces. The hoppers were further provided with drains and flushing nozzles for removing caught cinders periodically, and with make-up and overflow water connections. The photographs show a gang of elements which were installed in the first of the four catchers.

Cinder Accumulations

After a few days' operation, it became apparent that the efficiency of the catcher was being seriously impaired by accumulations of floating cinder on the water surface and by cinder and salt accumulations on the splash plates above the water level. It was necessary to provide means to skim off the floating cinder from water surface, and to remove cinder salt deposits adhering to the splash plates. Finally, the arrangement shown in the diagram was used, which provided a weir-type overflow at the center of the hopper, clear channels for water between splash plates, and nozzles supplying make-up water below the water level in each channel at the hopper ends, inducing a surface flow of water in the channel toward the center overflow. High-pressure nozzles were developed producing a concentrated water jet of low trajectory, and were installed so as to wash off the cinder salt deposits on the sides of the splash plates. Use of these cleaning nozzles once in 24 hr., during a period of low load, was sufficient to keep the splash plates clean.

One other operating trouble was a gradual accumulation of cinder salt deposits at the bottom of the inlet spaces. This resulted in unequal gas distribution, and a tendency to overload the unobstructed elements, causing carry-over of water at high ratings. The tendency to build up these deposits was most noticeable when operating at high ratings. Clean-out doors were installed in the top sheet of the inlet duct in such a position that the inlet passages could be cleaned with a rod. This weekly cleaning is now done at low load periods, without interfering with boiler operation.

Apparently no carry-over of water and cinders into the induced draft fans has occurred.

Certain maintenance troubles also developed. The first set of splash plates proved short-lived due to peeling off of the protective coating. A temporary installation of cast iron plates, $\frac{1}{2}$ in. thick, gave time for a trial of many of the corrosion-resistant alloys, but with little success. Finally, non-metallic materials were tried, and from among them a hydraulic-pressed composition board, with an asbestos base, was selected. This material is practically unaffected by corrosion, and is reasonably resistant to erosion. Splash plates formed of it have a life of over 18 months, and can be renewed at low cost.

After nine months of service, a gang of six elements inspected had scalloped lower edges which had receded $\frac{1}{2}$ to $\frac{3}{8}$ in. Where the guide vanes at the lower ends had been tacked to the elements, the enamel did not adhere well to the welds, and left points for corrosion to start. Further tests showed that more uniform gas distribution in the element was obtained by leaving out the guide vanes, and also that draft loss was reduced.

A series of efficiency tests run on the cinder catcher, covering a steaming range on the boiler of from 200,000 to 325,000 lb. per hr., showed an over-all efficiency varying from 80 to a maximum of about 84 per cent. It should probably be noted at this point that the catcher as built operated with a fixed water level, irrespective of gas flow, which gives a nearly flat efficiency curve. Operating in this manner, the draft loss was found to vary approximately as the square of the mass flow of gas. As a result of this operation, it was decided to equip the remaining three boilers of this installation, and the new installation of eight boilers, with this type of cinder catcher. The new boilers were being designed to generate a maximum of 530,000 lb. of steam per hour, and since the quantity of gas to be handled on the new catcher as compared to the preceding installation would be in the proportion of 5 to 3, it was decided to increase the cinder catcher dimensions a corresponding amount.

New Design

Experience had by this time shown that elements lower in first cost, and cheaper to maintain, could be had by assembling the element plates with bolted and gasketed joints and by providing them with a 6-in. renewable strip along the bottom edge. This construction is shown in the upper right-hand photograph. The first of this group of boilers was placed in service Jan. 30, 1932, and the last went into service June 11, 1932. No operating troubles have occurred to date. Twelve cinder catchers of this design are in daily operation at the station, on service boilers having a total steaming capacity of 5,560,000 lb. of steam per hour.

Our experience of nearly two years' successful operation with this type of cinder catcher has convinced us that it is entitled to claim the following advantages: High efficiency with any size cinders encountered in stoker practice. Low installation, operating and maintenance cost in comparison with any other equipment of equal efficiency. Large capacity for a given floor space (2,500 lb. of gas per hour can be cleaned per square foot of floor space, with a draft loss of $1\frac{1}{4}$ in.). A considerable portion of the sulphur content of the flue gas is removed. The cinder erosion on the induced-draft fans is materially reduced by the high efficiency of cinder elimination. The system for disposing of the caught cinders is simple, easy to operate and maintain.

NEW COMBUSTION CHART

Insures

SPEED—EASE—ACCURACY

By ERIC THERKELSEN
Professor Mechanical Engineering
Montana State College

THE problem of calculating the performance of fuel combustion apparatus, such as boiler, industrial and domestic furnaces or internal combustion engines, from an analysis of the combustion products is frequently surrounded with a great deal of uncertainty and even mystery. The engineer who has not had special training in the use of chemical formulas feels somewhat uncertain as to the best approach to combustion problems.

With this in mind, the following tabular method has been developed to help engineering students and practising engineers to visualize the relationships existing between the substances entering the combustion chamber and those coming out as combustion products. Chemical formulas are avoided in the solution and only the combining proportions are used. All of the computations are done on the calculation chart, thus greatly simplifying the work.

The fundamental principle involved in these calculations is that of the balance, that is *the total quantity of each chemical element entering the furnace or engine must equal the total quantity of the same element leaving the furnace or engine.* It follows then that the total weight of all substances entering must equal the total weight of all substances leaving. Fig. 1 illustrates the idea of the balance, the rectangle in the center representing the furnace (or engine) as being the beam of the balance. On the left-hand side we have (1) the fuel, consisting of C, H_2, O_2, S, N_2 and ash[1], and (2) the air, consisting of O_2 and N_2 entering the furnace. On the right-hand side we have leaving the furnace four substances, (1) ashpit refuse, (2) the "dry combustion products," (CO_2, O_2 CO and N_2), (3) water vapor, in a superheated state, formed by the combustion of H_2 to H_2O, and (4) sulphur dioxide (SO_2) from the S in the fuel.

The analysis of the combustion products is made by means of the Orsat apparatus and gives the percentages of CO_2, O_2, CO and N_2 by volume in the "dry" products. Since the apparatus uses water solutions, any gas sample that would be tested by it would have its water vapor condensed and its sulphur dioxide (SO_2) absorbed by the water of the solutions. Therefore the water vapor and the sulphur dioxide must be accounted for in another way. The ashpit refuse, being inert, does not enter into the calculations.

The fundamental combination formulas for the elementary substances encountered in combustion problems are shown in the following table:

$2\ H_2$	$+\ O_2$	$= 2H_2O$
meaning, 2 molecules of H_2	+ 1 molecule of O_2	= 2 molecules of H_2O
or, 2 mols H_2	+ 1 mol O_2	= 2 mols H_2O
$2\ C$	$+\ O_2$	$= 2CO$
2 mols C	+ 1 mol O_2	= 2 mols CO
C	$+\ O_2$	$= CO_2$
1 mol C	+ 1 mol O_2	= 1 mol CO
$2\ CO$	$+\ O_2$	$= 2CO_2$
2 mols CO	+ 1 mol O_2	= 2 mols CO_2
S	$+\ O_2$	$= SO_2$
1 mol S	+ 1 mol O_2	= 1 mol SO_2

In this table the term "mol" means "pound molecular weight," that is a number of pounds numerically equal to the molecular weight of the substance.[2] For hydrogen (H_2) this is 2 lb.; for oxygen (O_2), 32 lb.; for water (H_2O), 18 lb.; for carbon (C), 12 lb. (assuming carbon to be monatomic); for carbon dioxide (CO_2), 44 lb.; for carbon monoxide (CO), 28 lb.; and for nitrogen (N_2), 28 lb. Since air has an equivalent molecular weight of 28.9, one mol of air weighs 28.9 lb. It is important to remember that in one mol (or molecule) of CO there is one-half a mol of O_2. Likewise one mol of H_2O has one-half mol of O_2. On the other hand, one mol of CO_2 contains one mol of O_2.

These molal relationships will now be used in several illustrative examples. Assume in each case that the composition of the fuel is known and that during the combustion an Orsat analysis is made of the flue or exhaust gases. The problem is to determine from this information the complete picture of the combustion process.

There are three different classes of fuels requiring slightly different methods of attack.

1—Those fuels, the composition of which can be expressed by a simple chemical formula, for example:

a—Coke, practically pure carbon, C

b—Methane, CH_4; ethane, C_2H_6, etc.

c—Carbon monoxide, CO

d—Methyl alcohol, CH_3OH; ethyl alcohol, C_2H_5OH

2—Liquid and Solid fuels for which are known (1) the ultimate analyses in per cent by weight of their chemical elements, C, H_2, O_2, N_2, and S; and (2) the percentage of ash in the dry fuel. For example: fuel oil, gasoline, coal.

3—Gaseous fuels consisting of a mixture of gases ($H_2 + CO + CO_2 + CH_4 + C_2H_6 + C_3H_8 +$ etc. $+ N_2$) analyzed on a volumetric basis. For example: natural gas, producer gas, illuminating gas, blast-furnace gas.

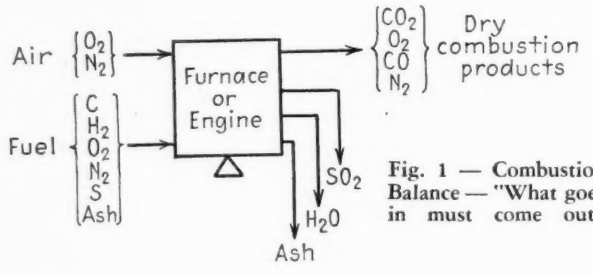


Fig. 1 — Combustion Balance — "What goes in must come out"

A Solution for a Gas Fuel

The use of this chart will now be illustrated for a simple gaseous fuel. Methane gas (CH_4) is burned in a furnace and the Orsat analysis of the flue gas shows CO_2, 6.15 per cent; O_2, 9.94 per cent; and N_2, 83.90 per cent. Calculate: (a) Cubic ft. of air per cubic ft. of methane entering furnace, (b) percentage of excess air, (c) the flue gas heat losses if the flue gases leave at 500 deg. F. atmospheric temperature being 60 deg. F.

Solution: Fig. 2 shows a calculation chart with the given data in heavy figures, the fuel composition on the left and the Orsat analysis on the right. As a basis for calculation assume that 100 mols of the "dry" flue gas had been caught in a vessel. Since a mol of a gas is a measure of volume (379 cu.ft. at 14.7 lb. abs. and 60 deg. F), there are 6.15 mols CO_2, 9.94

[1] It is customary to deal with the fuel on a moisture-free basis in these calculations even though the fuel might have a moisture content.

[2] An excellent discussion of the mol will be found in *Power*, Dec. 1932, p. 292, "The Mol" by E. F. Dawson.

mols O_2 and 83.9 mols N_2 in the vessel as shown in the "Mols" column.

According to the fundamental principle of the balance, the "carbon balance" tells us that there must be the same number of mols of C on the left-hand side as there are on the right. That is, the 6.15 mols of C in the 6.15 mols of CO_2 must have come from the fuel, and we can write 6.15 at once in the "mol" column in the "FUEL" rectangle opposite the C. This is pointed out by the arrow from the 6.15 on the right side to the 6.15 on the left side.

Now in the fuel (CH_4) there are two mols of H_2 per mol of C, so we may write 12.3 in the mols column opposite the H_2. Also we may write 6.15 in the mols column opposite "Fuel," since there is one mol of C per mol of CH_4.

The second step is the "nitrogen balance," which tells us that the 83.90 mols of N_2 must have come from the air, since the fuel has no N_2. Therefore insert 83.90 in the mols column opposite N_2 in the "AIR" rectangle as indicated by the arrow joining the two N_2 items. Now we know that the ratio of the volumes of O_2 and N_2 in the air is as 20.9 is to 79.1*; therefore the mols of O_2 entering with the N_2 are $\frac{20.9}{79.1} \times 83.90 = 22.20$ mols, which we write opposite O_2. The number of mols of air is the sum of the mols of O_2 and N_2, or 106.1.

Then the mols of air per mol of fuel, or cubic ft. air per cu.ft. fuel, equals $\frac{106.1}{6.15} = 17.25$ (see line 1). If it is desired to know the *weight* of air per pound of fuel the "Lb" column for fuel and air can be filled in by multiplying by the molecular weights, 16 for CH_4 and 28.9 for air, as shown in Fig. 2. The ratio of weights gives 31.2 lb. shown in line 2.

The 12.3 mols of H_2 in the fuel form the 12.3 mols of H_2O, shown on the right side of the balance, and require half as many mols of O_2, that is 6.15 mols.

The 22.2 mols of O_2 used are accounted for in the "Oxygen out" rectangle thus: 6.15 mols for C, 6.15 mols for H_2, 9.94 mols excess, the sum of which is 22.24 mols. The percentage is $\frac{9.94}{6.15 + 6.15} \times 100 = 80.9$ per cent, shown in line 3 of the chart.

The heat loss due to the 100 mols of dry flue gases equals:

$$L_g = M_g C_{mg} (T_g - T_r)$$

in which

M_g = number of mols of dry gases = 100 in this case.

C^{mp} = mean molal specific heat of the dry gases, assumed to be 7.1. For greater accuracy the specific heat for each gas for the particular temperature range should be used, and the B.t.u. loss per degree difference calculated for each gas.

T_g and T_r are temperatures of the gas and of the room or atmosphere respectively.

The calculation is shown on the chart of Fig. 2, line 5 (a), the loss being expressed per pound of fuel. Since 16 lb. (or one mol) of CH_4 occupies 379 cu.ft., one pound occupies $\frac{379}{16} = 23.7$ cu.ft., and the loss per cu.ft. of fuel is $\frac{1}{23.7}$ of that per pound of fuel.

The heat carried away by the superheated water vapor formed from the combustion of H_2 may be calculated by the equation

$$L_w = W_w (1090.6 - T_r + 0.46\, T_g)$$

in which W_w = weight of water vapor formed, in this case 221 lb. The calculation is shown on the chart in line 5 (c), the loss being expressed per pound of fuel.

A second, and concluding article by Professor Therkelsen will show how the same form is used to solve combustion problems using three other fuels: a commercial gas, coal and gasolene—EDITOR.

The standard computation form here presented is probably the best yet devised for the rapid and accurate solution of combustion problems involving solid, liquid or gaseous fuels. A single form, which will serve for any fuel, may easily be duplicated as mimeographed, zincographed or blueprinted sheets of 8½ x 11-in. notebook size

*For average conditions of latitude and altitude in the U. S., counting all inert gases N_2.

Fig. 2—Combustion Calculation Chart filled out for problem involving combustion of methane

Typewritten lettering is part of original mimeographed form. Heavy pen lettering represents test data entered in red. Light pen lettering represents computation entries in pencil.

COMBUSTION CALCULATION SHEET

Problem No. Methane Date Oct. 1, 1933 Name John Doe

NOTE: Use red pencil for the fuel used, the given data, and calculation basis assumed. Use black pencil for the derived or calculated data.

AIR			
Subst.	Mols		
O_2	22.20	20.9/79.1 N_2	
N_2	83.90	Lb.	
Air	106.10	3065	

FUEL: CH_4 Basis assumed:			
Subst	%	Mols	Lb.
C		6.15	
H_2		12.30	
O_2			
N_2			
S			
Fuel	100.0	6.15	98.4

Total weight in 3163

OXYGEN IN:	
O_2 from fuel	22.20 Mols
O_2 from air	Mols
Total O_2 in	22.20 Mols

FURNACE OR ENGINE

DRY COMBUSTION PRODUCTS Basis assumed: 100 Mols					
Dry Prod.	Mols	Orsat	Molal Sp. Ht.	Btu. Loss per °F.	Lb.
CO_2	6.15	6.15			271
O_2	9.94	9.94			318
CO					
N_2	83.90	83.90			2350
Total	99.99		7.1	710	

CO_2 ____ Mols; ____

H_2O 12.3 Mols; 221

Total weight out 3160

OXYGEN OUT:		
O_2 used for C	6.15	Mols
O_2 used for S		Mols
O_2 used for H_2	6.15	Mols
Excess O_2 out	9.94	Mols
Total O_2 out	22.24	Mols

6.15
6.15
12.30

1. Cu. ft. air per cu. ft. fuel in: $\frac{106.1}{6.15} =$ 17.25 ft^3
2. Pounds air per pound fuel in: $\frac{3065}{98.4} =$ 31.2 lb
3. Percentage excess air: $\frac{9.94}{12.3} \times 100 =$ 80.9 %
4. Temperature of entering substances, T_r, 60 °F; leaving, T_g, 500 °F
5. Heat losses per ~~pound~~ of fuel:
   (a) Due to dry gases: $\frac{100 \times 7.1 \times (500-60)}{98.4} =$ 3170 Btu.
   (b) Due to CO: ____ Btu.
   (c) Due to H_2O from H_2: $\frac{221(1090.6-60+0.46\times 500)}{98.4} =$ 2810 Btu.

POWER NOTES

Rubber is useful in many ways to eliminate noise. Here's a new one. A ¾-in. hydraulic pipe in one of the buildings of B. F. Goodrich Co., Akron, Ohio, developed a noisy water-hammer due to fluctuating pressure. No remedy could be found until an engineer substituted a piece of ¾-in. hose for a section of the pipe. This ended the trouble at once.

English Steel Corp. recently completed and shipped for service at Fulham power station a drum for a Stirling boiler measuring 54 in. in diameter by 40 ft. 9½ in. long, weighing 52 tons. It was forged in one piece, ends being closed by a special process. Similar drums are being made for Brighton and Swansea stations.

The first 42,000-kw. section of the Trebovice steam station in the Ostran-Karwin coal field of Austria brings a new high-pressure plant into operation. It has three Loeffler boilers, each capable of providing 126,000 lb. of steam per hr. at 1,985 lb. per sq.in. and 932 deg. F. Two 3-stage condensing turbines direct-connected to 6,300-volt alternators are used.

Blade Failures Decrease; Cause Less Turbine Outage

N.E.L.A. Prime Movers Committee report on turbines has been published by the Edison Electric Institute. The following abstract gives in full the provisions to reduce lubrication oil fire hazards.

THE REPORT on turbines published by the Edison Electric Institute contains 1932 operating records of 291 large turbines and 12 turbines operating above 1,000 lb. pressure. In it are included new data upon outages for inspection and overhaul, operating data and new information on blade erosion, statements on lubricating oil fires, new methods of inspecting blading for hair cracks, experiences with turbine gears, a new device for program loading of the station, data on removal of moisture at bleeder points, washing of soluble solids from turbine blades, and test data from the largest 1,200-lb. pressure turbine, and also the largest turbine of any pressure.

Decreased system load and the full use of available hydro-electric power resulted in a decrease in the output of individual steam-driven units as compared with other years. These combined causes reduced the unit operation factor for 1932 to 48.83 per cent as compared with 57.92 per cent for 1931, and 62.96 per cent in 1930. The greatest decrease in use occurred among those turbines which had been in use over 7 years.

The influence of the depression is shown in the decrease in the average output per unit of 23 per cent. This is not to be taken as representative of the decrease in system electrical output, as in many cases the systems include water-power plants which were given base loads in preference to the steam plant.

Turbine Outage Analyzed

Analysis of turbine outages shows considerable change in the distribution of outage hours in 1932 from those reported in 1931. It is evident that the newer forms of blades and buckets are giving better service, since outage from this cause decreased from 13.51 per cent in 1931 to 5.17 per cent in 1932. Outage due to wheels and spindles decreased from 4.01 per cent in 1931 to 2.77 per cent in 1932. On the other hand, outages due to nozzles and diaphragm, and shaft, showed an increase in 1932. A significant change is outage due to lubrication systems, which increased from 1.98 per cent in 1931 to 3.49 per cent in 1932. This increase is believed to be due to changes made in the various systems to increase their safety against oil fires.

Information gathered on annual inspection and overhaul showed that in 1932, 151 turbines were inspected requiring an average of 483 hr. each. Information collected on 138 turbines that had been in operation for three years, covering the duration of outage for inspection and overhaul in 1930, 1931 and 1932 seems to indicate that outage hours might be saved by less frequent inspection and overhaul than the former practice of once a year, unless outage is made necessary by some particular difficulty. The average outage period of 38 turbines overhauled and inspected once in three years was 639 each. The average total outage of 47 turbines which were overhauled and inspected twice in three years was 1,116 each. The average total outage for the three years of the 48 turbines inspected and overhauled yearly was 1,335 hours each, or an annual average of 445.

Data collected on 12 high-pressure units showed a decrease in turbine outage from 10.28 per cent in 1931 to 4.26 per cent in 1932, which is substantially the average for the larger groups of low-pressure turbines over the past few years. This would indicate that these high-pressure units had passed the experimental stage and can be regarded as equally reliable as the standard low-pressure turbines in current use.

Fires Originating From Oiling

Official statements are given in the report on fires at the Harding Street Station, and at Bremo Bluff, and an abstract of the account of the fire at the Brussels Station, Belgium. Investigation has also disclosed that small fires have been more frequent in power plants than formerly appreciated, being in most cases due to oil leaks or drips on the high-temperature steam piping or valve chests, the heat insulating material becoming oil-soaked and the oil then igniting. The report contains the following recommendations for lubricating systems, primarily to apply to large new turbine generator installations:

It is highly desirable that all storage of oil be removed from the immediate vicinity of the turbine unit and located preferably in a separate room which would contain the main oil storage tank, turbine oil coolers, and turbine oil pumps. If it is absolutely necessary that the main oil pumps be driven from the main turbine shaft, vertical pumps might be used, mounted on the basement floor with suction connections from the oil storage room running in a trench beneath the basement floor. This oil room should be so constructed that it would be impossible for oil to run out below the doors or through other openings, and the room should be arranged so that it can be sealed in case of fire and flooded with either CO_2 or steam.

There should be ample room around all tanks and other equipment so that they can be reached from every side and so that a proper degree of cleanliness can be maintained.

Separate lines should run from the oil pumps to the bearing lubrication system and to the high-pressure governing system. These lines should be provided with suitable valves, so that in case of trouble with the high-pressure system it can be shut off in bringing the machine down.

To provide proper segregation, oil lines of every description should be so located that they will be remote from hot steam lines or other hot surfaces, and wherever possible they should be protected either in floor trenches or in some other manner which would make it impossible for anything to strike them, for men to walk on them, or for other equipment to be suspended from them, thus minimizing the possibility of breakage or opening of joints. In cases where oil lines must pass over hot surfaces, the insulation for these surfaces should be protected with metal jackets. Oil lines should be made of extra heavy pipe or seamless tubing and steel fittings and valves. Joints should be avoided wherever possible by making bends and by welding, but where joints are necessary, they should be made with either tongue and groove or male and female flanges with narrow metal gaskets. All screwed flanges, if used, should be back welded. In locating these joints due consideration should be given to the hazard involved. Joints of hydraulic cylinders, bearing housings, or other turbine equipment should be made in a similar manner.

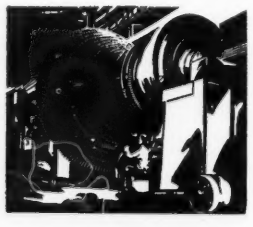
Gage lines should not be smaller than $\frac{1}{2}$ in. in size and should be constructed of heavy materials. Where these connections are made to the reservoir or piping, they should be made with heavy steel tubing, screwed and welded with a steel shut-off valve located as near the source of supply as possible. Beyond the shut-off valve copper tubing may be used.

Gage glasses should be avoided, and mechanical or pressure type gages should be used for indicating oil levels. Operating cylinders for governors, control valves, intercepting valves, etc., should be placed underneath the valves or steam chests wherever possible, and should be located preferably in the basement. There should be no steam pipes or other hot surfaces beneath these cylinders. It is highly important that this oil piping be made accessible for routine inspection and repairs.

Consideration should also be given to making the bearing lubrication system and governing system two entirely independent systems with separate pumping and cooling equipment for each. With this arrangement it might be possible to use some non-inflammable liquid other than oil, such as a derivative of diphenyl or of diphenyl oxide, for the governing system, and the lubrication system could then be protected by gravity or pressure tanks so that the supply would be assured in case of trouble with the pumping equipment, etc.

Recommendations for Present Plants

On existing equipment it will be very difficult if not impossible to effect all of the above recommendations. It is suggested, however, that each plant be studied carefully and changes made where necessary to make the equipment as safe as pos-



sible consistent with avoiding excessive expenditures. The following specific recommendations are made as part of this program:

1. Make sure that oil piping, valves, and fittings are constructed of proper material and that outlets for gage lines, etc., are properly made and properly valved. Eliminate all fittings and gasketed joints above danger areas as far as possible.

2. Where it is impossible to move oil lines from the immediate vicinity of hot steam pipes, install barriers or cover the steam lines with metal jackets.

3. Separate the lubrication system from the high-pressure governing system as far as possible.

4. Wherever oil reservoirs are located immediately adjacent to the turbine or are part of the turbine base, extend all vents so that they will not be discharging oil vapors in the immediate vicinity of the turbine, and if possible provide connections for draining the oil from these reservoirs quickly. Valves in such connections should be remotely controlled.

5. Remove all gage glasses and substitute float indicators.

6. Provide means for flooding the exterior of oil reservoirs with water to prevent heating of the oil in case of fire.

Also have plenty of water available for flushing escaping oil into drains.

7. Provide proper and adequate fire protection equipment. A definite procedure for the care and use of this equipment should be set up in so far as the conditions warrant. Definite instructions should also be issued for handling the turbine and auxiliary equipment in case of fire. A routine for inspection of all turbine oil equipment and piping should also be established.

Minneapolis Building Installs Own Plant

The new electric plant in the Metropolitan Bank Bldg., Minneapolis, has stirred considerable interest in Twin City engineering circles because this 12-story structure, with a volume of 2,164,817 cu.ft. above ground, had purchased all of its current from Northern States Power Co. since the time of its erection in 1916. It is expected that the degree of success achieved by this installation will have a direct bearing upon the power policies of other building owners in this locality. It is too early yet to determine exactly the savings that will be effected, but results so far have been satisfactory.

Commonwealth Electric Co., Saint Paul, secured the contract. There is one 15x16 heavy-duty, used, horizontal Skinner "Universal Unaflow" engine, rated at 200 r.p.m., with a 5-in. steam line and 7-in. exhaust, direct-connected to a 75-kw., 2-wire, 250-volt, compound-wound Triumph d.c. generator, complete with a Crocker-Wheeler balancer set for 125/250-volt service. The other unit is a 16x16 used, Skinner counterflow engine, rated at 250-r.p.m., direct-connected to a 125-kw., 3-wire, compound-wound Western Electric 125/250-volt d.c. generator. The Skinner system of automatic lubrication is used on both engines.

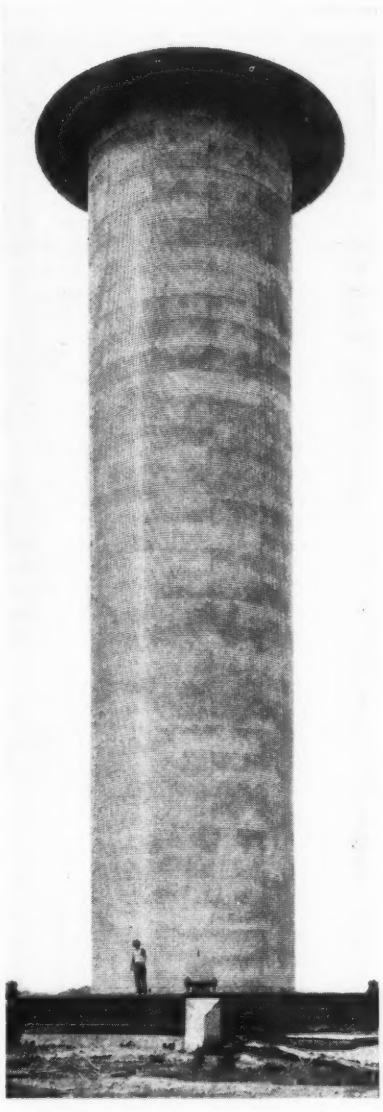
A new switchboard, with two generator panels and one balancer set panel, was provided, and it was linked with the old feeder panels which were left intact.

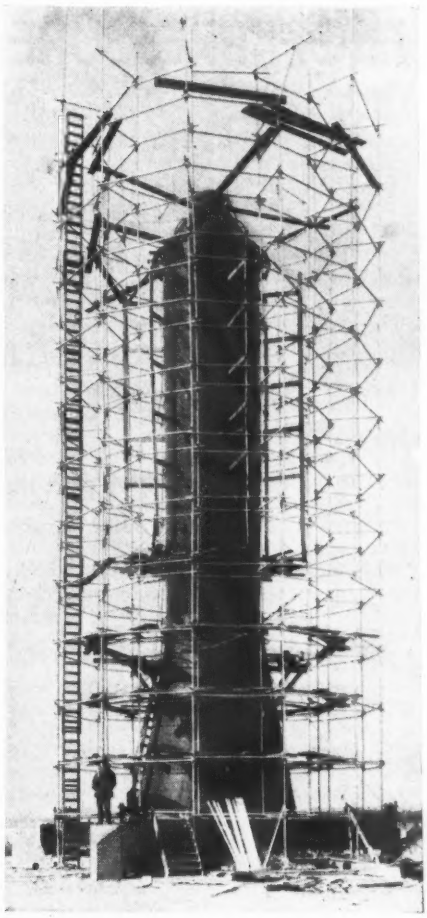
The Commonwealth company also installed a 6x6½ vertical Worthington, water-cooled, feather valve air compressor, with multi-V-belt drive from a 10-hp., 220-volt d.c. motor, rated at 1,800 r.p.m. An automatic switch controls this unit, which has a displacement of 52-cu.ft. of air when operating at 450-r.p.m.

All necessary steam and exhaust piping, fittings, pipe covering and electric wiring came with the machinery. The foundations, however, were furnished by the plant. Engine beds are insulated from the floor by 1½ in. of cork, the result being that only a negligible amount of vibration finds its way into the building frame.

Two Heine 1,600-sq.ft. boilers, equipped with V-type Detroit stoker, are operated alternately in this plant, which also includes three elevator pumps, operated singly in propelling the four Otis lifts. One is a Worthington Laidlaw, rated 12-14-14-7½-18. The others are Americans, rated at 10-16-9¼-20.

With normal tenancy, that is, about 90 per cent, the total building load on a dark winter day will pass 125 kw. Present vacancies in the structure, together with summer sunshine, make it possible for the 75 kw. engine to handle the load with ease.





ROTOR TURNS FOR NEWS MEN

● BEFORE assembled engineers, news men, and a battery of still and motion-picture cameras, inventor Julius R. Madaras demonstrated a full-size wind-power rotor unit Oct. 20 at Burlington, N. J. With an 11-mile wind blowing, the 4,000-lb. duralumin shell, 90 ft. high and 22.2 ft. in diameter, was spun smoothly at a rim speed of 50 miles per hour.

No power was generated by the wind rotor. Generation of power by this equipment will require mounting the rotor on a railway truck and moving it, with other similar rotors, around a large circular track. It is proposed to utilize the pressure on the rotating towers to push the tower cars along the track and, through generators mechanically connected to the wheels, produce electricity.

The object of the spinning of the rotor, which actually consumes a portion of the power generated, is to increase enormously the net thrust tending to transport the car. The principle involved is the well-known "Magnus effect," illustrated by the side draft of spinning baseballs and artillery projectiles.

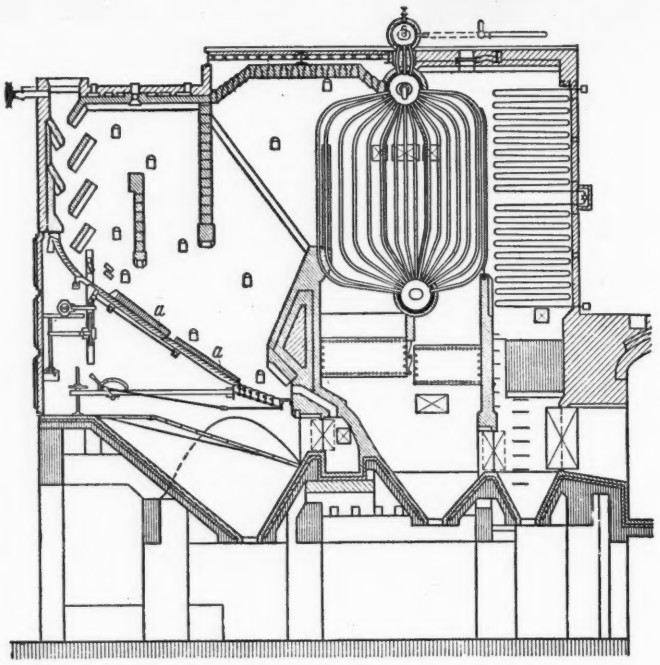
Before the rotation demonstration, visitors inspected the machinery basement, under the tower. There they saw the heavy steel strain gages designed to measure thrusts of 15 tons or more. The accompanying photographs give a general idea of the construction. Above is shown the stationary support, in the form of a steel-plate tower tapering to a bearing at the top.

HIGH-PRESSURE STEAM IN GERMANY

By DIPL. ING. G. LEUNIG

English version by Colmar Krause, German correspondent of Power

Among the notable high-pressure steam plants in Germany is that of the Ilse Bergbau A.G., a lignite-plant, non-condensing installation, furnishing large quantities of process steam and byproduct power. Steam at 1,700 lb. and 885 deg. is generated in vertical-tube, two-drum boilers by 3,600-B.t.u. lignite



Borsig two-drum boiler generates steam at 1,700 lb. and 885 deg. Superheaters are located after second pass (below lower drum). Note predrying section of stoker feeders for the moist, low-heat-value lignite fuel

GERMANY, like the United States, has seen a rapid development of high-pressure plants. The experiences of both nations with high pressures have much in common, as well as significant points of difference.

All agree that the increase of steam pressure up to about 100 atoms. (approx. 1,400 lb. per sq.in.) means reduction of coal costs. Construction costs for high-pressure condensing power stations with two-drum boilers, under present-day conditions in Germany, are estimated at about 5 to 10 per cent higher than for medium-pressure plants of the same output. With regard to maintenance costs: It must be considered that in the beginning of operation every novel plant is confronted with certain initial troubles from which later-built plants of the same type are free. It is expected that the building and maintenance costs of high-pressure stations will in the future be more and more in line with those of medium-pressure stations.

For German conditions, most experts agree that high-pressure stations should be considered only if a high load is to be expected continuously. This was the prevailing point of view when the 100-atmos. super-power-station at Mannheim was under consideration. The Mannheim station is a base-load plant, and thus insures a rather uniform and high load.

Germany Favors Special High-Pressure Boiler

Developments in the design of high-pressure boilers have proceeded along different roads in Germany and the United States. In the United States, the ordinary vertical-tube boiler or sectional boiler has been used from the outset, while Germany has developed special types as well as adapting ordinary designs to high-pressure steam operation. Such special types are the Schmidt-Hartmann boiler and the Loeffler boiler, in which natural or forced circulation of a heat-carrying medium is used to transfer heat from the tube surface to the steam drum. Another special boiler is the Benson, in which steam is generated at the critical pressure (224 atmos. = 3,200 lb. per sq.in.) and in which, consequently, no special steam space is needed.

Some of the main reasons for developing these special types were these: When operating ordinary boilers at high pressure it was feared that the water circulation might be disturbed and that considerable trouble might result from scale formation or corrosion. Another reason is the desire to reduce, or eliminate, the cost of high-pressure boiler drums. These special types have not yet been generally introduced into practice, because the experiences so far gained in the few, and mostly small, plants of these types are not enough for judging the proper working of these processes. It is chiefly for these reasons that the two large German high-pressure power stations, namely the 1,400-lb. plant at Mannheim and the 1,700-lb. plant at the Ilse Bergbau A.G., near Senftenberg (Middle Germany), were fitted with ordinary vertical-tube boilers.

Existing American and German plants show that the most economical steam pressures in ordinary boilers of condensing power stations range between 1,200 and 1,700 lb. In case of pressure ranges of from 700 to 1,200 lb. the economic advantages are considered to be not great enough to justify the higher costs and more complicated construction of such plants, due to the steam reheaters and forged or welded boiler drums, which are necessary in this range of pressure.

How far the steam temperature can be increased without imperiling the safe operation of a plant is differently considered in the United States and Germany. Apart from the high-temperature Delray station, the highest temperature of superheated steam in American high-pressure plants is, if we are rightly informed, around 825 deg. F. German experts, however, are of the opinion that the high-pressure steam, on account of its more efficient cooling effect, can be superheated far more than medium-pressure steam. For this reason, the high-pressure station at Mannheim, and that of the Ilse Bergbau A.G. work with superheated steam of 880 and 885 deg. F. Initial troubles, chiefly caused by creep of metals at these temperatures, are now overcome by the use of suitable materials and by proper design.

In the United States furnace gas is generally used for reheating the steam, whereas live steam is used in Germany. Plants for reheating by live steam are simple and less expensive. They require little space. Because of the short pipe lines the pressure and temperature losses are slight.

The Ilse Bergbau A.G. Plant

In some industrial plants, existing process heat requirements particularly favor the use of high-pressure steam. The German lignite mines offer particularly favorable conditions, as is demonstrated by the development of the heating and power station of the Ilse Bergbau A.G.

The lignite is obtained by open mining. With an original water content of from 50 to 60 per cent, the lignite is dried by steam of from 30 to 60 lb. pressure, thus reducing the water content to from 12 to 18 per cent. Finally, the lignite is pressed to briquettes without adding any binders. These briquettes are mainly used as domestic fuel.

The consumption of energy in lignite mines is very high. Apart from driving the briquetting presses much energy is needed for removing the thick layer of overburden from the lignite fields, as well as for drawing off the water from the open mines.

As early as 1894, the Ilse Bergbau A.G. erected boilers carrying a pressure of 185

lb. At that time, this pressure was regarded as very high. A new briquetting plant with a boiler pressure of 285 lb. was planned in 1914, but could not be completed until after the war. Another increase in the boiler pressure took place in 1923, when an order was placed for five 485-lb. pressure boilers with a heating surface of 4,300 sq.ft. each.

Even this plant could not long satisfy the increasing need for electric current. To avoid installing condensing turbines, the Ilse Bergbau A.G. finally decided to enlarge the out-of-date power station of the Renate Mine by adding three 1,700-lb. boilers with a heating surface of 5,370 sq.ft. each and two 12,000-kw. bleeding back-pressure turbines. To begin with, only two vertical-tube boilers with superheaters, economizers, and air heaters were ordered from Messrs. Borsig, Berlin-Tegel.

These boilers have only two drums, which are placed one over the other. To insure a circulation of water in one direction only, the downcomers are arranged outside the furnace-gas passages. The normal steaming capacity of each boiler is 75,000 lb. per hour, the maximum being 88,000 lb. The temperature of the superheated steam is constantly kept at about 885 deg. F. by desuperheaters. Crude lignite with a lower heating value of about 3,600 B.t.u. per lb. is burnt on 19.7 ft. wide, mechanically operated, step-grate stokers, built by Keilmann & Voelker, Bernburg.

The two 3,000-r.p.m., A.E.G., bleeding back-pressure turbines, of which one serves as a standby, have three casings, arranged in tandem. Steam enters the turbine at 1,400 lb. and 840 deg. F. After leaving the second casing at 192 lb. and 430 deg. F., the steam is led into a live-steam reheater whereby its temperature is raised to 545 deg.

Before entering the third casing, 66,000 lb. per hour of the steam are bled for driving the briquetting presses and 24,200 lb. per hour for driving the turbines of the boiler feed pumps. The remainder is then led into the third casing to generate current. At a pressure of 35 lb., the exhaust steam is finally led to the dryers. Exhaust from the steam engines and auxiliary turbines is also utilized in the dryers.

At the highest steam consumption of 210,000 lb. per hour, the output of the turbine is 12,000 kw. The most favorable efficiency, however, is at a consumption of 190,000 lb. per hour, that is, at approx. 90 per cent of the maximum load. Each turbine is coupled to a 17,150-kva. generator.

Practical Results

For several years, the high-pressure plant has worked satisfactorily after having overcome the initial troubles which occur with every novel plant. These difficulties, however, were exclusively of a minor nature and practically nowhere due to the high pressure.

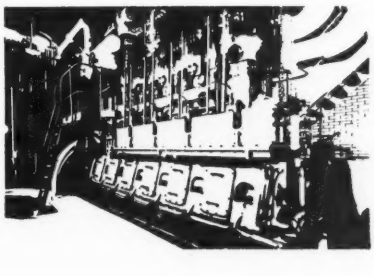
Practically all the early shutdowns of the boilers were caused by the effects of the high temperatures in the furnace. These caused the lignite ashes to melt and led to destruction of the brick settings. These difficulties have been overcome by improving the heat transfer from the furnace to the tube system. Another shutdown was caused by steam formation in the feed pumps and resulted in bursting of a tube. Troubles of this nature will be entirely avoided in the future by altering the construction of the suction and overflow pipes.

Condensate from the coal dryers in the briquetting plant is used as feed water. The slight remainder of water-hardness is removed by adding some trisodium phosphate. The oil content of the condensate coming from the steam engines driving the briquetting presses causes no trouble. The interior cleaning of the boiler is restricted to the removal of slight deposits of sludge in the lower drum and deposits of oil in the upper part of the upper drum. Every day the boilers are blown down for 60 to 90 min. through narrow orifices behind the sludge valves. Although the content of oxygen in the feedwater amounts to about 0.05 milligrams per liter, no symptoms of corrosion have been observed. It is assumed that this is due to the perfect circulation of the feed-water in consequence of the non-heated downcomers.

Tests have shown that a steam generation of 88,000 lb. per hour could be stopped after about 4 min. Little fluctuation of steam pressure is observed during load changes. Owing to the high density of the steam, the water level remains almost calm, and therefore, the generated steam is very dry. No serious troubles have been observed with the flange joints of the steam lines, even in view of the high temperatures and the considerable strain they were subject to in consequence of the fact that the plant is stopped and re-started every week. Some slight leakages that occurred in the beginning were removed by altering the packing. In the future, the flange bolts are to be made from molybdenum steel because the original bolts of special steel have elongated a little in service. The electrically welded feed-water pipes proved to be satisfactory.

REFRIGERATOR PROVIDES HEAT

● AT THE Ancoats Hospital, Manchester, England, advantage is being taken of the fact that a refrigerating machine supplies heat in convenient form for utilization. A methyl-chloride apparatus is operated to maintain a room temperature in one part of the hospital at about the freezing point, but the condenser of the machine, instead of being cooled in the open air, is enclosed in a duct. A fan provides a draft through the duct, and the effluent heated air is delivered to the hospital linen cupboards for drying purposes. Cost of heating and refrigeration is proportionately lower than if both functions of the cooling machine were not utilized.



CIRCULATION PLUS SEPARATION

● PROBLEMS of boiler design and operation have taken on new importance with the advent of high pressures. In particular, those of circulation and dry steam are again to the fore. Experience both here and in Europe has shown that rapid circulation in water-tube boilers is essential, with the present high rates of heat transfer, and that neglect in this respect must lead to tube failure.

The problem is to obtain this rapid circulation without increasing the moisture in the steam delivered by the boiler. Disturbances of the steam-liberating surfaces are necessarily great with rapid circulation, particularly at high boiler ratings. The result is a higher moisture content of the steam rising from these surfaces. While the situation is somewhat improved by the relocation of the tubes in the drum, so that they discharge their water-steam mixtures into the drum with a minimum of disturbance, trouble from wet steam seems to be unavoidable unless additional precautions are taken.

Some engineers have undertaken to insure dry steam by placing restrictions in the boiler circulation, but this is a backward step which eventually may lead to tube trouble. The cure is to be found not in restricted circulation, but in improved steam separators in the boiler drum.

NEW SOURCE OF INDUSTRIAL STEAM

● A NEW source of supply for steam, applicable to a wide variety of industrial processes, has been brought to light by the installation of a household oil furnace in a printing plant. The Maqua Company, Schenectady, N. Y., had been paying $1,326 per 6,000-hr. year for steam at 14½ lb. pressure to heat wax-form melting trays, water process baths, and driers in the electrotype room. A temperature of about 245 deg. F. is necessary to melt the wax; any temperature above that results in an excess loss of heat in the room.

The G. E. oil furnace installed is designed primarily for home heating and for supplying sufficient hot water for year-around household needs. It is controlled by a pressure switch which operates the furnace automatically to generate steam at between 12 and 14½ lb. per sq.in. pressure whenever the electrotype room is in operation. This gives a steam temperature of from 244 to 249 deg. F., satisfactory to melt the wax without excess heat wastage.

The installation will pay for itself in about a year, for with normal operation at 6,000 hours per year, the fuel will cost $396 at $0.06 per gal. and electric power $40 at $0.03 per kw.-hr., or a total operating cost of $436, giving a saving of $890 per year when compared with the previous operating cost.

WHAT'S NEW IN PLANT EQUIPMENT

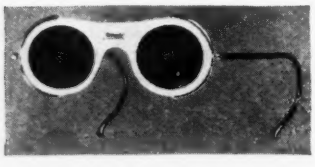
Variable-Speed Motor

Sterling Vari-speed motors have heavy, wide, high-speed V-belt running on two V pulleys mounted on fixed parallel shafts. Diameters of pulleys changed simultaneously (to obtain desired speed) by small handwheel. Proper belt tension maintained automatically. "Slo-speed" gears can be built integral with output shaft to provide single or double reductions for slow speeds down to 5 r.p.m. Very high speeds up to 15,000 r.p.m. also if desired. Available in open or closed types and variety of ratings, ratios and combinations. Ball-bearing equipped throughout. Unit shown is 15-hp., running at 1,200 r.p.m. maximum and 300 minimum. Fully enclosed.

Sterling Electric Motors, Inc. Telegraph Rd. at Atlantic Blvd., Los Angeles, Calif.

Welding Spectacles

For oxy-acetylene welding and cutting, Oxweld No. 15 welding spectacles have lenses in canvas-bakelite frames. New Type AA lenses are 50 mm. wide, providing wider angle of view with greater protection. Bows covered with insulating material; frame non-inflammable



and non-heat conducting. Snap device where temples or bows meet frame permits changes of lenses.

Type AA lens, flat ground and polished, is made in light, medium and dark green shades. Conforms to all code requirements, including Federal, and meets rigid specifications for eye protection.

Linde Air Products Co., 30 East 42nd St., New York City.

Electric-Contact Gages For Draft, Pressure

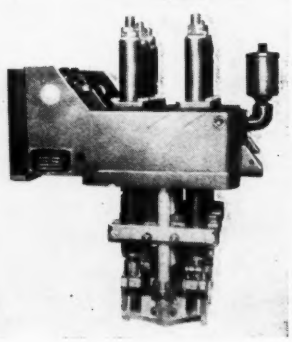
Hays dry-type actuating units used in this complete line of compact electric gages for draft, pressure and differential draft or pressure in ranges from 0.1 in. to 100 in. water. For high or low-contact service or for both, with closed mercury switches or open contacts. Small cast-aluminum case accommodates either one or two single- or double-contact units or a single- or double-contact unit and a unit which indicates on 3-in. scale pressure or draft being measured. Case made air-tight for differential pressure or draft service. Simple and accessible sensitive adjustments. Used in drying, ventilating, dust-collecting and similar systems or in conjunction with intermediate devices to open and close dampers, start and stop fan or vibrator motors, etc. Bulletin available.

The Hays Corp., P. O. Box 299, Michigan City, Ind.

Oil Circuit Breaker

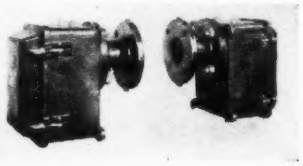
Rectangular-tank Type CR-30AT, 15-kv., 600 amp., 3-pole breaker with interrupting capacity of 50,000 kva. at rated voltage. Fabricated steel head gridded on inside. Lamphenite insulated studs cross-braced with treated wood. Lift rods guided by rollers and cross-tied to insure positive contact alignment. Main contacts silver surfaced. Self-contained shock absorbers. Main shaft bearings bronze bushed. Multi-part oil retractor separates oil from gases during arc extinction, allowing gases to be carried away through header.

Delta-Star Electric Co., 2400 Fulton St., Chicago, Ill.



Smoke-Density Recorder

Photo-electric unit indicates on meter degree of density of smoke passing through stacks or breechings. Recorder added to give running record. Comprises light source and photo-electric relay mounted on opposite sides of stack, covered by lenses kept clean by drafts of clean air.



Lenses easily accessible for cleaning. Each unit in cast-iron case with heavy flanges for mounting. Electric contact for operating alarm circuit provided which can be adjusted to any point between 20 and 60 per cent of full density.

General Electric Co., Schenectady, N. Y.

Dual-Ventilation for Motors

This newly developed system makes possible enclosed motors up to 200 hp. with mounting dimensions comparable to those of open types. Internal and external air are circulated by fans through paths which cause rapid transfer of heat from internal air to frame and thence to external air. Frame contains two sets of ducts, as shown. First set runs from one end of frame to other inside motor. Internal ventilating air is drawn by internal fan through air gap and rotor core vent holes, then driven through stator-coil end turns and through internal ducts over stator core. Second set of ducts alternate with first and pass from each end to center of motor. Double-end ventilation is used on larger machines. Since ducts carry external air in close to frame, a heat-exchanger effect is produced.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Synchronous Motors

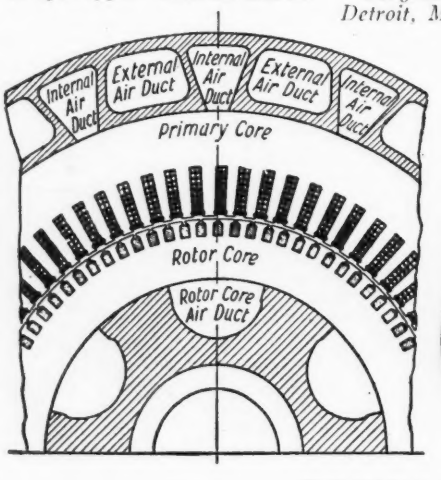
These small and medium-capacity synchronous motors may be installed as easily as ordinary induction motors. Starting and pull-out torque about same as squirrel-cage motors, thus may be applied to any drive. Self-synchronizing and separately excited. Give leading power factor of 0.9 at full load. Poles fitted with amortisseur windings for high starting torque. ½ hp. at 1,800 r.p.m. up to 40 hp. at 900 r.p.m. Bulletin S-1.

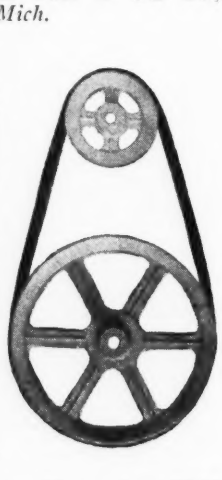
Columbia Electric Mfg. Co., 1292 East 53rd St., Cleveland, Ohio.

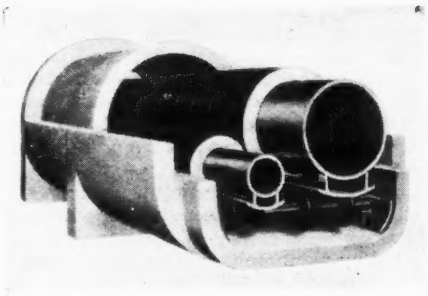
Pulleys and Couplings

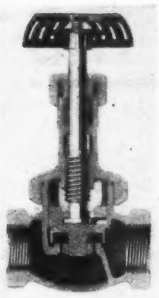
This new series of pulleys and couplings comes in variety of sizes to fit A and B type V-belts for power transmission. Designed to fit belt accurately. Die cast from white brass, diamond bored, balanced to avoid vibration at high speeds. Sizes in round-belt and V-belt types.

Congress Tool & Die Co., Detroit, Mich.









Steam Pipe-Line Conduit

USCCO precast concrete conduit gives greater strength, capacity and economy than earlier designs. Simple and flexible to install. Shape increases capacity 12 per cent over that of circular conduit and gives space for saddles and roll supports. Only two sections, tops and bottoms, with bell and spigot joints sealed with mortar or joint compound. Built on job in 4-ft. lengths, with cast-steel pipe supports inserted where necessary.

Underground Steam Construction Co., 75 Pitts St., Boston, Mass.

Instantaneous Unloader for Small Refrigerating Compressors

This automatic instantaneous unloader is an automatic pressure - differential - operated bypass valve connected between suction and discharge of compressor. Valve operates by gas pressure differential and is controlled by magnetic pilot valve controlled in turn by frequency-responsive relay on motor-starting panel. When motor is started, pilot valve is energized and a small amount of high-pressure ammonia gas is admitted to unloader to actuate it. This gas is returned to low-pressure side of system to avoid leakage and waste. No springs used, and mechanical construction simple. Automatic start and stop operation of compressor secured by instantaneous unloader, compressors starting and stopping by brine thermostats, suction-pressure control or other means to maintain desired temperatures. Instantaneous unloader avoids shut-downs due to voltage dips in power supply, thus avoiding loss of refrigeration.

Electric Machinery Mfg. Co., Minneapolis, Minn.

Non-Metallic Disk Valve

Fig. 123 "N-M-D", non-metallic disk bronze valve suitable for 150-lb. steam pressure and 300-lb. gas-liquid pressure. Has deep non-heat malleable iron handwheel with easy grip. Bronze gland has hexagon head. Stem is rolled bronze. Long threads fully engaged with bonnet thread when valve is closed. Shoulder above stem thread seats tightly against bottom of stuffing box, making valve repackable under pressure. Disk holder is of slip-on type. Extra long guides insure accurate seating. Three basic types offered —steam, hot water, cold water —air. Other disks available to suit conditions. Available in several designs—globe, angle, horizontal and angle check, spring check for compressors. All patterns described and listed in Booklet F-593.

The Lunkenheimer Co., Cincinnati, Ohio.

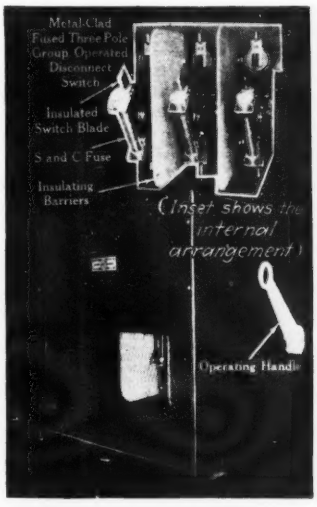
Oil Clarifier

Portable absorption unit connected directly to crankcase of internal combustion engine and operates during running of engine. Pressure percolation used, pressure of engine lubricating system being utilized. Removes carbon, water, acid and dirt. Claimed unnecessary to replace oil; merely to make-up as used and replace filter cartridge periodically. Model H for diesel or gasoline engines of less than 250 hp. Model J for lighter-duty equipment requires greater frequency of changing filter element.

Briggs Clarifier Co., Transportation Bldg., Washington, D. C.

Metal-Clad Fused Switch

For service up to 15 kv., this metal-clad switch is safe, convenient and easily installed 3-pole group-operated switch for industrial plant service. Three switch blades carrying fuses are interlocked and simultaneously opened and closed by means of locking-type external handle. Screened opening permits easy inspection of fuses and gives ventilation. Above screened opening is panel removable for replacement of blown fuses.


Metal-Clad Fused Three Pole Group Operated Disconnect Switch
Insulated Switch Blade
S and C Fuse
Insulating Barriers
(Inset shows the internal arrangement)
Operating Handle

Delta-Star Electric Co., 2400 Fulton St., Chicago, Ill.

Industrial Tester

This portable a.c. test set, called Industrial Analyzer, tests apparatus and motors up to 100 hp., 440 volts. Makes complete tests up to 125 amp., 500 volts a.c. and is actually miniature portable 3-phase switchboard panel in case complete with necessary switching equipment, transformers and resistors. Unit includes triple-scale ammeter, 0-5, 0-25 and 0-125 amp., triple-range voltmeter, 0-150, 0-300, 0-600 volts; polyphase wattmeter with three scales for above ranges; and polyphase power factor meter with 10-100-80 scale. Instruments of new miniature type with standard mechanism. Scales 3½ in. long. Two special light - weight current transformers with hipernik cores and primary winding tapped for 5, 25 and 125 amp. connected into circuit in 3-phase wiring scheme to provide multiple current ranges. Voltage ranges obtained by switching tapped resistors in the potential circuits.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Compensated Vacuum Gage

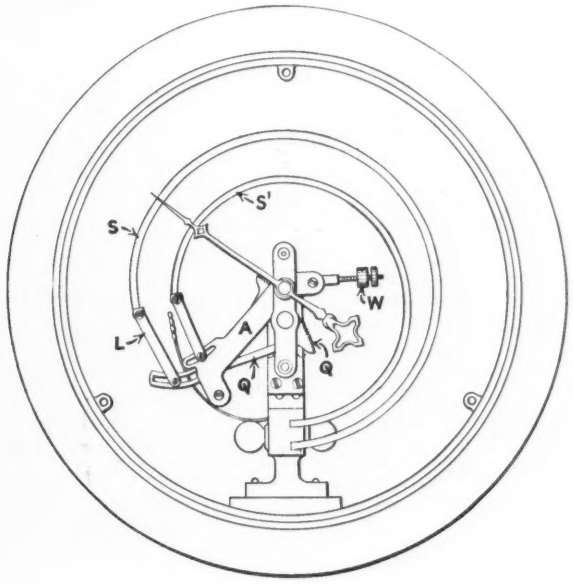
Because of high vacuum at which steam turbines operate, a close check must be had on vacuum if turbines are to operate at maximum efficiency. To accomplish this requires a vacuum gage that reads to a high degree of accuracy, a requirement not met by the conventional type of spring-operated gage, not compensated for changes in temperature or barometric pressure. Corrections must be made for these before the reading can be used as true values.

This new vacuum gage is compensated for both temperature and barometric pressures. Bearing friction has been made very low, and to obtain greater reading accuracy, pointer travels nearly 360 deg. Figure shows instrument operating mechanism. Spring tube *S*, link *L* and quadrant *Q* are same as in conventional gage, except that friction of moving parts has been reduced to a low value and movement has been counterbalanced by weight *W*. In conventional gage, pivot of quadrant *Q* is fixed, while in compensated gage, compensation for temperature and barometer is obtained automatically by shifting position of quadrant's pivot, which is suspended on jewelled bearings between two arms *A*. Center of these bearings coincides with center of pointer spindle, but quadrant moves in an arc about this spindle. Position of quadrant pivot is shifted automatically by spring tube *S'*, evacuated and sealed.

Assume that a change in temperature or barometer affects spring tube *S* and causes it to move rack of quadrant *Q* to left and pointer clockwise. Tube *S'* will also act and will cause arm *A* to move downward and result in quadrant rack and pointer being returned to their original position.

Developed by Comdr. C. J. Odend'hal, U. S. Coast Survey, and marketed by:

United States Gauge Co., 44 Beaver St., New York City.



POWER LINES

Roosevelt Signs Twelve Codes Touching Power Field

Up to Oct. 23, President Roosevelt had formally signed, and thereby made into law, more than 50 industrial codes under the N.R.A. Of these, 12 touched more or less the interest of *Power* readers, as buyers of power equipment and related materials.

Following is a tabulation of these codes, with their sponsoring associations:

Industry	*Sponsor*
Electrical Manufacturing	National Electric Mfrs. Assn.
Steel	American Iron & Steel Inst.
Cast Iron Coil Pipe	Cast Iron Coil Pipe Assn.
Coal (Bituminous)	
Oil Burner	American Oil Burner Assn.
Ice	National Assn. of Ice Industries
Heat Exchanger Industry (Includes steam and vapor condensers, tubular heat exchangers, storage heaters, direct contact heaters, deaerators, cooling towers, etc.)	Heat Exchange Institute
Pump Manufacturing	Hydraulic Association
Batteries (Storage and wet primary)	National Battery Mfrs. Assn.
Boiler Manufacturing	American Boiler Mfrs. Assn.
Automatic Sprinkler	National Automatic Sprinkler Assn.
Compressed Air (Manufacturers of air compressors, etc.)	Compressed Air Institute

Of particular interest to *Power* readers is the Code of the Boiler Manufacturing Industry, particularly the clause therein specifying that no sale may be made below cost, as determined by the standard system of the Machinery Builders Society. The Code prohibits contracts with a penalty clause, unless a bonus is provided for at the same time.

The total number of codes (for all industries) already presented at N.R.A. headquarters, runs into hundreds. The stage of rapid acceptances has now been reached and it is expected that by the middle of November at least 100 additional codes will have received the President's signature. *Power* plans next month to list any additional signed codes touching the power field.

Any of these codes may be obtained by sending five cents to the Superintendent of Documents, Washington, D. C. Ask for the "Code of Fair Competition for the ..... Industry as Approved by President Roosevelt."

Boulder Dam Generators to be World's Largest

Boulder Dam's electric generators will be the world's largest both electrically and physically, it has been announced. A contract for two machines has been awarded by the United States Bureau of Reclamation to General Electric Co., and for two more to Westinghouse Electric & Mfg. Co. These generators are rated 82,500 kva., unity power factor, 3-phase, and are designed for 50-cycle generation at 150 r.p.m. and 13,800 volts or 60-cycle generation at 180 r.p.m. and 16,500 volts. A fifth generator, rated at 40,000 kva., was awarded to the Allis-Chalmers Mfg. Co.

Four 82,500-kva. generators will be installed for the opening of the station, and ultimate plans call for a total of 15 such units. In addition, the 40,000-kva. generator will be installed now, and another one later.

The Boulder Dam generators will be smaller in diameter but both higher and heavier than the U.S.S.R. generators. The two to be constructed now by General Electric will have an over-all diameter of 40 ft. and height of 32 ft. above floor level. Each will weigh more than 2,000,000 lb.; the U.S.S.R. units, the previous heaviest ones, weigh approximately 1,800,000 lb.

The rotor, including its 115,000-lb., 38-in. diameter shaft, will weigh 1,250,000 lb. At least 40 freight cars will be required for the transportation of each unit, including generator, regulator, surface air coolers, and exciters, from Schenectady to Boulder Dam. The frame will be shipped in four sections.

Because of special problems encountered in the transmission of the power over the distance of 265 mi. to Los Angeles, special features of design will be incorporated in the units, making them equivalent in size to generators of approximately 125,000-kva. capacity in units of normal characteristics.

Two of the 82,500-kva. generators will normally be operated in parallel and will be connected to one bank of step-up transformers, consisting of three 55,000-kva. single-phase transformers connected delta on the low-voltage side and star on the high-voltage side. A 13,800/16,500-volt transfer bus will be provided so that a spare 82,500-kva. generator may be substituted for any other 82,500-kva. generator without dropping load, and the low-voltage switching equipment will have sufficient interrupting capacity to permit three main generators being connected to the transfer bus simultaneously. The power generated by these units will be transmitted to the city of Los Angeles by means of two transmission circuits operating at 275,000 volts at the receiving end and from 280,000 to 303,000 volts at the sending end.

Refrigerating Engineers To Meet in New Orleans

The National Association of Practical Refrigerating Engineers plans to hold its Twenty-fourth Annual Convention and Educational Exhibition at the Roosevelt Hotel in New Orleans, Nov. 8-11. It immediately precedes the annual meeting of the Ice Industries Association, which convenes the following week at the same hotel. Edward H. Fox is secretary, 435 No. Waller Ave., Chicago.

Missouri River Diversion Seen Worth $60,000,000 Per Year

At a cost of $60,000,000, the Missouri River Diversion project is planned to divert and control the flood waters of the upper Missouri near Garrison, N. D., storing them behind a great dam for 150 miles up the Missouri and in the great Devils Lake water basin. The dam will create a lake in the river basin extending as far as Williston. From a creek flowing north out of the big bend, water will be conducted by open canals to a tunnel in the Coteau du Missouri, some 15 miles through

Aerial View of the Schenectady Mercury-Steam Plant, now nearing completion

the hills, and thence by canal to the headwaters of the Sheyenne and James Rivers southwest of Harvey. The reservoir will store 15-million acre-feet of water—about three-quarters of the annual flow. The diversion tunnel will handle about 1 per cent of this water, which will be taken at the flood period. It has been estimated that more than 30,000 hp. will be available, sufficient to furnish electric power to the entire drought area, or to all North Dakota.

Machinery & Allied Products Institute Appoints Executive Committee

Appointment of an executive committee of thirteen members to direct the affairs of the Machinery & Allied Products Institute, one of the largest industrial groups brought into being by the N.R.A., has been announced. Included in the committee are George H. Houston, president of Baldwin Locomotive Works; I. N. Beeler, representing the Steam Engine Manufacturers Association; W. C. Dickerman, president of American Locomotive Co., representing the Diesel Engine Manufacturers Association; Robert E. Friend, president of Nordberg Manufacturing Co., representing Hoist Builders Association; Russell C. Jones, vice-president of Griscom-Russell & Co., New York, N. Y., representing the Heat Exchange Institute; D. C. Keefe, executive vice-president of the Ingersoll-Rand Co., representing Compressed Air Institute; C. E. Searle, executive vice-president of the Worthington Pump & Machinery Corp., representing Hydraulic Institute; and George P. Torrence, president of Link-Belt Co., representing the Association of Conveyor and Material Preparation Equipment Manufacturers. Other members include Harold C. Smith, C. S. Wagner, A. M. Mattison, J. G. Benedict, P. C. Brooks.

Continue to Develop Canadian Water Power

During the ten months of the current year, work has continued on several large Canadian water-power developments already under construction at the beginning of the year. In Quebec, Maclaren-Quebec Power Co. completed and brought into operation its 136,000-hp. plant on the Lievre river. Shawinigan Water & Power Co. recently announced resumption of work on its development at Rapide Blanc on the St. Maurice river near La Tuque. Owing to a greatly increased demand for power, it is planned to have an initial installation of 80,000 hp. ready for operation by May 1, 1934. Beauharnois Light, Heat & Power Co. has recently awarded a contract for five additional units in its plant at Beauharnois. These are each of 50,00-hp. capacity, and installation will extend from December, 1934, until 1937.

In Ontario, the uncompleted Canyon development of Ontario Power Service Corp. on the Abitibi river was acquired by the Hydro Electric Power Commission of Ontario and work was resumed on the installation of generating machinery. Two of the 66,000-hp. units are at present in place.

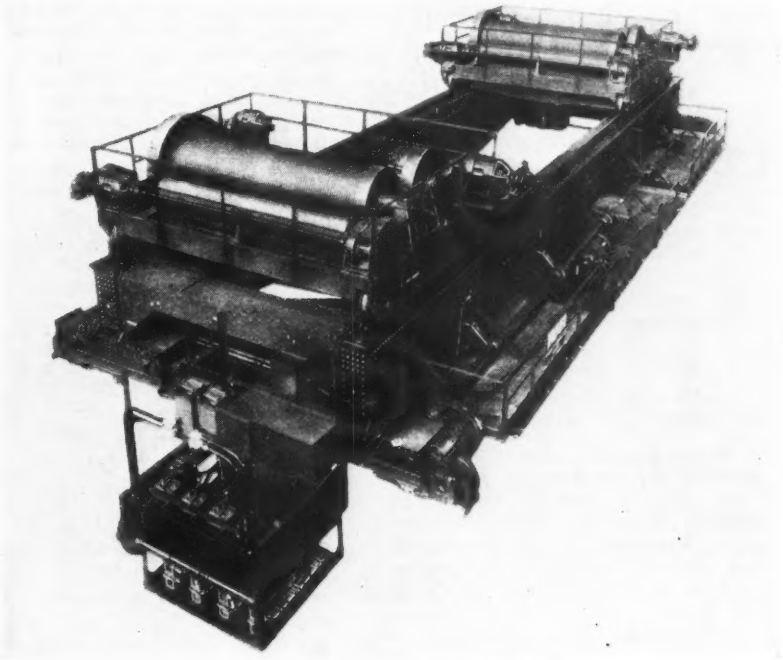
In British Columbia, West Kootenay Power & Light Co. continued construction of a development on the Goat River near Erickson which will have an initial installation of 800 hp. and an ultimate capacity of 1,600 hp. No other water-power undertakings of magnitude are at present under construction in the Dominion.

Power Plant Stolen

An oil-engine-generator set supplying power and lights for the summer restaurant of Charles S. Howard on Manomet Hill, Plymouth, Mass., was stolen the night of Oct. 16. The unit, weighing something over 500 lb., was taken by truck.

Naval Architects & Marine Engineers Meet in New York This Month

The Society of Naval Architects & Marine Engineers is holding its 41st annual meeting at the Engineering Societies Building, 29 West 39th St., New York City, on Nov. 16 and 17. Included in the papers are several which may be of interest to engineers of stationary plants. These include: "Diesel versus Steam Drive for Cargo Ships," by Louis R. Ford, "Water Circulation and Gas Path in Naval Boilers," by Rear Admiral Samuel M. Robinson, USN., and "Water Conditioning and Related Problems of Marine Boiler Operation," by Dr. A. C. Purdy.



300-Ton Power-house Crane

With a span of 60.5 ft., this 300-ton overhead traveling crane has been supplied by Harnischfeger Corp., Milwaukee, Wis., for the Diablo dam power house of the City of Seattle, Wash. Two turbines, each of 83,000-hp. under 330-ft. head, are being installed. The crane has two trolleys, each with a main hoist of 150 tons and an auxiliary of 25. Maximum height of lift is 65 ft. The whole crane, unloaded, weighs 175 long tons.

PERSONALS

COL. EDWARD M. MARKHAM has been appointed chief of engineers of the Army with the rank of Major-General, and will take over the duties of the office about Nov. 1. Gen. Lytle Brown, whose tour of duty expired Sept. 30, has been continued at the head of the Corps of Engineers with the title of Acting Chief of Engineers. General Brown will return to the line of the Army.

PERCY S. YOUNG, vice-president in charge of finance, Public Service Corp. of New Jersey and subsidiary companies, has been elected vice-president of the American Gas Association.

DR. H. J. ROSE, senior fellow of Mellon Institute of Industrial Research, has been elected chairman of the Gas and Fuel Division of the American Chemical Society for 1933-34, in recognition of his research on solid fuels.

W. K. LEACH has become general manager of the Alloy Division, American Manganese Steel Co. He was formerly with General Alloys Co.

GEORGE W. FARNHAM, for the past eleven years with the McGraw-Hill Book Co. as manager of the Educational Department, is heading the College Department of International Textbook Co.

OBITUARIES

CHARLES PIEZ, 67, past president of the American Society of Mechanical Engineers and chairman of the Board of Link-Belt Co., Chicago, died Oct. 2 at the Garfield Hospital, Washington, D. C. Mr. Piez, with Charles M. Schwab, directed the wartime work of the Emergency Fleet Corp. He had also been twice president of the Illinois Manufacturers' Association. His health had been failing for the past five years, and since February last he had been wholly inactive in business.

BUSINESS NOTES

LEWIS E. TRACY CO., Boston, Mass., has been appointed Boston territory distributor by Chain Belt Co.

DETROIT TOOL & FORGE CO., 656 Smith Ave., Detroit, is now manufacturing the Minard economy air valve and oil filter for air-operated equipment, formerly made by National Sales Engineering Corp., Detroit.

MCCLAVE-BROOKS CO., Scranton, Pa., has appointed Sanford C. Smith Refractories, Inc., 1709-1715 Niagara St., Buffalo, N. Y., as exclusive sales representative in Ohio, West Va., western Pa. and central and western N. Y.

SMOOT ENGRG. CORP., has moved its general offices and factory to Summit, N. J. The former address at 136 Liberty St., New York, is still maintained as a sales office, with H. R. Kessler in charge. A Pittsburgh office has been opened under management of Col. C. L. Joly at 405 Bessemer Bldg., and a Chicago sales office will be opened shortly.

THE ROLLER-SMITH CO., 233 Broadway, New York, N. Y., has appointed H. R. Houghton, 211 North Calvert St., Baltimore, Md., as district sales agents for the State of Maryland.

C. W. YOUNG & CO., INC., investment managers, Chrysler Bldg., New York City, have added Frank M. Gentry as manager of their public utility department.

CEDARBURG MFG. CO., Cedarburg, Wis., has acquired the property and patents of American Electric Motor Co., formerly a subsidiary of Splitdorf-Bethlehem Electrical Co., Newark, N. J. Cedarburg will continue manufacture of American Electric motors in sizes from ½ to 30 hp. Thorv. Hansen, formerly works manager of A. O. Smith Corp., Milwaukee, is president and general manager, and Crawford Perego, vice-president in charge of sales.

SARCO CO., INC., New York City, has appointed two new representatives, H. C. Freese, 811 East Armour Blvd., Kansas City, Mo., and Colby Equipment Co., 136 N. Delaware Ave., Indianapolis, Ind.

WESTINGHOUSE ELEC. & MFG. CO. has moved its New York sales and executive offices to the RCA Bldg., 30 Rockefeller Plaza, New York City.

D. W. HAERING & CO., INC., Chicago, has opened a New York office at 1451 Broadway, and appointed William Wright as district manager.

CLAY ENGINE SERVICE CO., 7010 Hampstead Ave., Cleveland, Ohio, has purchased the marine division of the Clay Engine Manufactring Co., and is now servicing engines manufactured by the former company. In the near future the new company will begin to manufacture vertical gas engines from 6 to 100 hp., running at 75 to 400 r.p.m.

DOMAN-MARKS ENGINE CO., Syracuse, N. Y., is moving its plant to Amesbury, Mass., in order to obtain greater production facilities.

NORTHERN EQUIPMENT CO., Erie, Pa., has appointed C. J. Gaskell, Box 162, Memphis, Tenn., as representative there.

STRAWS

Pointing the way the business wind blows

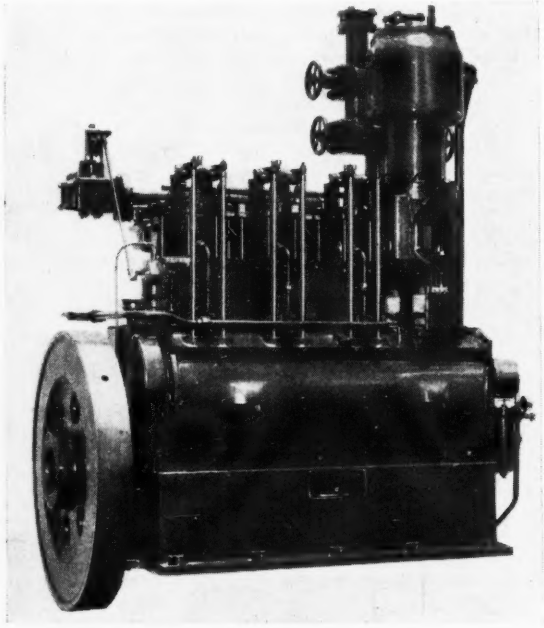
Plans are maturing for several new municipal light and power plants in Missouri municipalities. Cape Girardeau is concluding financing for $685,000 for new steam-electric generating plant; plans drawn by Burns & McDonnell Engrg. Co., Kansas City, Mo., consulting engineer; the same engineers are making surveys and estimates of cost for a municipal power plant at Fredericktown. Concordia has approved bonds for $70,000 for new municipal lighting plant; plans by W. B. Rollins & Co., Kansas City, Mo. Last-noted engineers have plans for an electric light and power plant for Monroe City, estimated to cost about $60,000, with equipment. St. Charles will soon build municipal plant to cost about $300,000; Russell & Axon, St. Louis, consulting engineers; financing is being arranged. O'Fallon is arranging for a bond issue of $145,000 for municipal plant.

Board of Trustees, University of Washington, Seattle, is planning construction of an addition to power plant, to cost about $150,000. Plans of College of Engineering.

Newcastle, Ind., is considering extensions and improvements in municipal electric light and power plant. Program will cost close to $400,000. F. Taylor, City Hall, city engineer.

The D. L. & W. Railroad has purchased eight 600-hp. diesel locomotives to be powered with McIntosh & Seymour high-speed diesels, and four, each to be powered with two 325-hp., 550-r.p.m. Ingersoll-Rand diesels.

Stanolind Pipe Line Co. has purchased a 750-hp., 17x25-in., 3-cyl., 257-r.p.m., two-cycle, solid-injection diesel from Nordberg Mfg. Co., to be direct-connected to a reciprocating pipe line pump.



One ammonia cylinder, 7¼x9 in., and three power cylinders, 10½x9 in., comprise this vertical gas-engine compressor unit made by Worthington for Calhoun Ice Co., Calhoun, Ga. The unit operates at 450 r.p.m. to develop 179 hp. Connecting rods of the power cylinders and the ammonia cylinder operate on the same crankshaft and in the same frame

Plans are being projected by Sharon and New Castle, Pa., for construction of a joint steam-electric generating plant. Sharon Tax Justice League, J. A. Loch, chairman of utilities committee, in charge, and New Castle Tax Justice League, respectively, are sponsoring. A tract of 5 acres of land on the Shenango River is being considered. Entire project will cost close to $1,000,000.

Goshen, Ind., is arranging financing for extensions and improvements in municipal electric light and power plant and waterworks, estimated to cost approximately $400,000, with equipment. Bemis Co., Chicago, Ill., is consulting engineer.

Sibley, Iowa, has plans for extensions and improvements in municipal electric light and power plant and waterworks pumping station, including installation of new 4,000-sq.ft. boiler and accessories, electric-pumping machinery and other equipment. Work will cost about $35,000. Currie Engineering Co., Webster City, Iowa, is consulting engineer.

Superior, Wis., has authorized surveys and estimates of cost for a new municipal steam power plant for central heating service in business district, including underground pipe lines. Frederick C. Perry, Duluth, Minn., is consulting engineer.

Fairbanks, Morse & Co. has recently sold a 1,050-hp. diesel to Thief River Falls, Minn., as an addition to the town's diesel power plant, and has also taken the contract for a municipal light and power plant for Mora, Minn.

Three Oklahoma municipalities have made application for Government loans for municipal electric light and power projects. Hominy proposes a fund of $150,000. Chandler is seeking an appropriation of $130,000 for steam-electric plant. Pawnee is raising a fund of $60,000 for extensions and improvements in present station.

Oberlin, Ohio, has purchased 2,500 hp. in diesel engines from Fairbanks-Morse Co. for its municipal plant.

Joseph Reid Gas Engine Co., Oil City, Pa., has just sold a 13¼x18-in. single-cylinder horizontal full diesel developing 90 hp. at 275 r.p.m., to handle a lineshaft for building and charring whiskey kegs for Allied Barrel Works, Oil City, Pa. This company has also sold five diesels in oil fields, another for a pipe line, and three for beam-pump drives. This plant, until recently, was working 24 hours a day to meet orders.

Hopes of Vancouver, B. C., to secure municipal power from hydro-electric development of the Cheakamus River were crushed recently when engineers reported that Garibaldi Lake water escapes by subterranean seepage, which cannot be avoided in any normal dam construction.

Electrical equipment totaling more than a million dollars for the six 1,500-ton United States Navy destroyers being built in private shipyards has been ordered from Westinghouse. This includes condensers, air ejectors, forced draft blowers, pumps, switchboard and other electrical auxiliaries.

To provide cheap electric power to mining concerns operating in the Bridge River gold camp of British Columbia, B. C. Electric Railway Co. will construct a 4,600-hp. plant at Bridge River. This will be a hydro plant to replace private plants of gasoline and internal combustion engines.

Westminster Paper Co., Ltd., of New Westminster, B. C., will construct a new power plant to cost $50,000. This will be in addition to the company's boiler plant.

Construction of the new electric light and power plant to serve the Creston Valley of British Columbia will be completed this month. The new plant is being erected by West Kootenay Power & Light Co., at Goat River Canyon. Three turbines are being installed, two being 800 hp., and one 250.

A fund of about $130,000 is being arranged by the Board of Essex County Freeholders, Hall of Records, Newark, N. J., for extensions and improvements in Overbrook Hospital, Verona, to include purchase of two new generating units and accessories, and pipe-line materials for water service.

Lynchburg, Va., city officials have contracted with Ford, Bacon & Davis for a report on the survey made this year by Wiley & Wilson, of Lynchburg, on plans for a municipal electric light plant.

Chicago Pneumatic Tool Co. has recently shipped two 300-hp., 6-cyl., 400-r.p.m., 10¾x13¾-in. diesels to India Wharf Brewing Co., Brooklyn, N. Y.

Nordberg Mfg. Co., Milwaukee, Wis., has sold a variable-speed Corliss long-stroke engine, 26x54, to Hawaiian Sugar Co.

Keystone Silver, Inc., and Triangle Thread Mills, both of New York City, have entered into contracts with John H. Neafie, Inc., for Atlas Imperial diesels.

Remsen, Iowa, has purchased a 220-hp., and 240-hp. diesel engine-generating sets for the town's new light plant from De La Vergne Engine Co.

During the next two months the Tennessee Valley Authority will spend a million and a half dollars for materials for Norris Dam and a transmission line between that dam and Muscle Shoals. About three-quarters of this amount will be spent in Cleveland, Detroit, Chicago, Pittsburgh, New York and other cities for essential machinery. The Authority has placed an order with the National Cast Iron Pipe Co., Birmingham, Ala., for 3,800 ft. of 8-in. cement-lined cast-iron pipe for the water supply at Norris Dam. The pipe will be used for conveying water from a large spring to a reservoir from which it will be distributed.

East Point, Ga., is planning to purchase three diesels from Fairbanks-Morse for its new municipal light plant to replace purchased power.

Fire spread by burning grass, Oct. 8, ignited the Mississippi College power plant at Clinton, totally destroying the unit, with a loss of several thousand dollars. The one-story frame building housed two Fairbanks-Morse engines, with generators. The unit is for auxiliary electric power supply.

Bevin Bros., Easthampton, Conn., is adding a 170-hp. De La Vergne engine to its plant. The company manufactures bells, and has had one diesel in constant service for more than 20 years.

Osceola, Ark., is opening bids Oct. 30 for a 600- or 700-hp. diesel engine-generator set as an addition to its municipal lighting plant.

Bellingham, Wash., is planning a municipal hydro plant on Lake Whatcom.

Bath, N. Y., is completing its diesel plant, which will replace the steam plant of the village for generating electrical power. It will include a 300 and two 450-hp. vertical Worthington diesels in a building of cinder block. Other recent Worthington sales include two more 600-hp. engines for Balatog Mining Co., in the Philippines, both of the split-frame design previously used, two small engines for Standard Oil of Indiana for pipe lines, and two 1,250-hp. horizontal, twin-tandem gas engines for a northern New York State pipe line.

FEDERAL ALLOTMENTS

Recent Federal Public Works allotments include a loan and grant to Danville, Va., for a hydro-electric plant, $3,000,000; to Pecos, Tex., for power and irrigation, $2,600,000; San Francisco, Calif., for a 200,000-kw. hydro plant in Tuolumne County, $1,400,000. The Danville allotment is for construction of a 10,000-kw. hydro-electric plant with dam and tunnel, and necessary transmission lines and substations. The Pecos allotment is for construction of an earth dam with power house and transmission line, to be used for irrigation and power generation. Brownsville, Tex., has also been allotted $200,000 for rehabilitation of its electric light plant, $47,400 of it being a grant.

A grant of $15,000, without loan, was made to Thief River Falls, Pennington County, Minn., to aid in the construction of a power plant and water works, of which the total cost of labor and material will be $57,500. Work can begin in November and be completed in 2½ months.

A grant of $39,000 was made to Baltimore, Md., to aid in the construction of a pumping station. No loan was requested. Total cost of the project will be $160,000. Work can begin in November and be completed in nine months.

A grant of $10,000, without loan, was made to the State of Illinois, for use in the construction of a boiler house and repair to heating system at the Soldier's Widows' Home at Wilmington, Ill. The total cost of the project is $39,000. Work can start in November and be completed in four months.

A grant of $7,700, without loan, was made to the State of Illinois for installation of new boilers, stokers and ash conveyor at the St. Charles State School for Boys. Total cost of job is $30,000. Work can start in November and be completed in three months.

Other recent grants include: State of Massachusetts, loan and grant, $48,000, for two new boilers at the State Infirmary Tewksbury, Mass. Work begins in November and will be completed in five months. Another loan and grant to Massachusetts of $360,000 is for a new power plant for the State Insane Hospital, Northampton, Mass. Work begins this month. The same state has been allotted $132,000 for boiler plant extensions and alterations at the State Insane Hospital at North-Grafton. Work begins this month.

State College of Washington, Pullman, Wash., receives $198,000 for a power and boiler plant and other buildings.

Randolph, Wis., receives $1,300 toward a municipal heating plant building.

Wilmington, Del., receives $72,000 for remodeling boiler and turbine rooms, etc., in the city pumping plant.

Macon, Ga., receives $36,000 for the same use.

Alexandria, Minn., receives $21,000 to aid in alteration of existing light plant.

Appropriation of $20,000,000 for the Bonneville Dam from P.W.A. funds to the War Department early in October set the wheels in motion for the first Federal power development on the Columbia River. The site chosen is at the head of tide-water, approximately 40 miles east of Portland, Ore. Power development plans call for initial installation of 90,000 kw. capacity in two nits of 45,000 kw. each. Foundations will be provided in the power house for four additional units of equal capacity with space left for a total of ten or twelve, giving possible ultimate maximum of 540,000 kw. Navigation facilities are to be provided by locks.

Actual work at the site was commenced within two weeks after the appropriation. Total cost is estimated as $31,000,000.

Public Works Administration, on Oct. 18, allotted $360,000 to the State of Massachusetts for the construction of a new power plant at the State Insane Hospital at Northampton. Thirty per cent of the cost of labor and materials is covered by an outright grant of approximately $84,000. Work is to be begun within a month.

Shenandoah, Ia., has received a Federal allotment of $38,000 for a new filtration plant and diesel engine-generator. No loan was requested. The allotment is 30 per cent of the cost of labor and material on a $125,000 project.

New Bulletins

Squirrel-Cage Motors—Reliance Electric & Engineering Co., Cleveland, Ohio, has issued Bulletin 116 on Form OSH, Type AA Reliance motors for flywheel applications.

Rotary Condensation Meters—American District Steam Co., North Tonawanda, N. Y. Twelve-page bulletin No. 415; complete information on construction, application, operation, testing, maintenance and installation of ADSCO rotary meters.

Silicon Bronze—Bridgeport Brass Co., Bridgeport, Conn. 24-page booklet; physical properties and applications of three high-strength silicon bronzes sold as "Duronze" alloys. For bolts, hot-water storage tanks, ducts, shafting and pump rods, etc.

Spiral Bevel Gear Reducers—D. O. James Mfg. Co., 1114 W. Monroe St., Chicago, Ill. 48-page catalog; spiral bevel-gear reducers and spiral bevel gears.

Feeder Voltage Regulator—Allis-Chalmers Mfg. Co., Milwaukee, Wis. Four-page bulletin 3021; new automatic feeder voltage regulator.

Metal-Clad Switchgear—Delta-Star Electric Co., 2400 Fulton St., Chicago, Ill. Sixteen-page bulletin; metal-clad switchgear in Vernon, Calif., Municipal Diesel Station.

Welding Stainless—Republic Steel Corp., Central Alloy Division, Massillon, Ohio. 17-page booklet, "The Welding of Enduro Stainless Alloys," gives complete data.

Boiler Regulator—Northern Equipment Co., Erie, Pa. Booklet No. 133; Cope double-control regulator which feeds boiler according to the rate of steam flow, correcting for water level changes.

Cable Sockets—John A. Roebling's Sons Co., Trenton, N. J. Eight-page bulletin describing new "No-Pinch" wedge socket for wire rope.

Pneumatic Refractory Application—The Gunitor Co., 1227 W. Beardsley Ave., Elkhart, Ind. Six-page bulletin one pneumatic applicator for concrete, cement or refractory, recently described in **Power.**

Electric Ventilating Fans—Buffalo Forge Co., Buffalo, N. Y. Four-page bulletin No. 475-C on Baby Conoidal ventilating fans.

Side-Suction Volute Pumps—Morris Machine Works, Baldwinsville, N. Y. Sixteen-page bulletin on recent improvements in pumps; for capacities up to 14,000 g.p.m. at heads up to 120 ft.

Pumps and Compressors—Nash Engineering Co., South Norwalk, Conn. Thirty-five-page catalog; vacuum pumps, compressors, Jennings vacuum heating pumps, sump and sewage pumps, sewage ejectors, and self-priming centrifugal pumps.

Water Treating—D. W. Haernig & Co., Inc., 3408 Monroe St., Chicago, Ill. Sixteen page booklet describing application of H-O-H treatment to water problems.

A. C. Generators—Allis-Chalmers Mfg. Co., Milwaukee, Wis. Four-page bulletin No. 1558 on bracket bearing a.c. generators from 30 to 1,000 kva., for coupled or belted service to high-speed steam or internal combustion engines and for gearing to steam turbines.

Insulation Tests—Acheson Oildag Co., Port Huron, Mich. Bulletin No. P171, "A Method of Making Electrical Contact with Ebonite and Soft Rubber for Insulation Tests."

Stokers—Riley Stoker Corp., Worcester, Mass. A 24-page bulletin on new improved Jones side-dump stoker, showing details of typical installations.

Compressors and Pumps—Worthington Pump & Machinery Corp., Harrison, N. J. Bulletin W-850-B32, 8 pages, on 120 cu.ft. per min. portable air compressors; B33, 240-cu.ft., B-34, 310-cu.ft., and B37, 360-cu.ft. Also D111-S4A on Hivol piston pumps, 8 pages, and D-111-S3A on horizontal piston pumps, 2 pages. 4-page bulletin on refrigerating compressors.

Piping—Benjamin F. Shaw Co., Wilmington, Del. A 32-page bulletin, "Piping, Fabrication and Installation in Power and Industrial Plants."

Vertical Motors—Wagner Electric Corp., 6396 Plymouth Ave., St. Louis, Mo. Loose-Leaf bulletin sheet on three types of vertical motors.

Steam Traps—W. H. Nicholson & Co., Wilkes-Barre, Pa. Bulletin No. 833, covering "Nicholson" industrial steam trap suitable for all pressures up to 150 lb.

New Plant Construction

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Ark., Russellville—Arkansas Polytechnic College plans heating and power plant and engineering building. $300,000.

Calif., Healdsburg—Geysers Development Co., 417 South Hill St., Los Angeles, preparing plans power plant, consisting of two 1,000 kva. turbo-generator units with necessary power lines and appurtenances for delivery of electricity; installing low speed, multi-cylinder heavy duty gas engine and 3-phase, 60-cycle, 2,400 volt, 100 kva. alternating current generator and exciter.

Calif., Montebello—City Council instructed City Attorney to make application to Federal Government for $400,000 loan to finance construction of municipal light and power system.

Ill., O'Fallon—City, R. Kampmeyer, mayor, election Nov. 29, to pass on proposal that city construct municipal power and light plant and issue $145,000 on bonds to finance the plant. Est. $143,000. W. A. Fuller Co., 2916 Shenandoah Ave., St. Louis, Mo., engrs.

Ind., Cicero—City plans municipal electric light plant. N.R.A. project. T. Wynne Co., Indianapolis, Ind., engr.

Ind., Columbia City—City Power & Light Co., Columbia City, making plans installing new turbine. $75,000.

Ia., Grundy Center—City plans electric power plant, $120,000. H. L. Cory, Baum Bldg., Omaha, Neb., engr.

Ia., Guthrie Center—City completed surveys, plans and specification extending distribution system, 150,000 gal. steel tank, 19,000 ft. 4- to 8-in. c.i. pipe, 250 g.p.m. removal plant, 1 high service pump and wash water pump. Buell & Winter, Sioux City, engrs.

Kan., Washington—City, A. N. Holloway, mayor, plans new municipal light plant, $88,000 voted for same. E. T. Archer & Co., 609 New England Bldg., Kansas City, Mo., engrs.

Mass., Dorchester—Commonwealth of Massachusetts, Dpt. Mental Diseases, State House, Boston, plans power plant, oil tanks and wiring at Boston State Hospital, $422,000 funds allotted by P.W.A. R. D. Kimball Co., 6 Beacon St., Boston, engrs.

Mich, Beulah—City filed application for Federal aid under terms P.W.A. for waterworks system, incl. pumping equipment and distribution system. $36,400. Francis Eng. Co., 204 Eddy Bldg., Saginaw, engrs.

Mich., Clifford—Village retained Francis Eng. Co., engrs., 204 Eddy Bldg., Saginaw, to prepare preliminary plans and estimates for complete waterworks system, incl. wells, pumping station and watermains. $30,000.

Mich., Davison—City plans completed and application filed with P.W.A. for Federal aid in financing for complete new waterworks system, incl. 2 deep well turbine pumps, two 300 g.p.m. motor driven deep well turbine pumps, $52,000. Geo. H. Ruhling & Co., 900 Lawyers Bldg., Detroit, engrs.

Mich., Hazel Park—Oakland and Macomb Counties, preliminary plans and estimates being prepared for sewer or covered drain to serve parts of Oakland and Macomb Counties and pumping station to pump sewage to disposal plant at proposed site near Thirteen Mile Rd. and Dequindre St. $3,500,000. Petition to be filed for Federal aid in financing under P.W.A. L. C. Jerroendt, Pontiac, Oakland County drain comr.

Mich., Lapeer—State, Home and Training School, sketches and estimates by Maul & Lenz, 1257 David Whitney Bldg., Detroit, proposed group of institutional buildings incl. remodeling and enlarging power plant and other buildings. $1,000,000. Federal aid to be asked by State for financing.

Mich., Menominee—City, A. B. Siegel, clk., will make application for Federal aid for municipal electric light and power plant. $650,000.

Mich., Northville—Detroit House of Correction plans extension to power plant now in use and equipping with one 500 hp. boiler, stokers, ash handling equipment, etc., at Dehoco, near here. $25,943. Plans under supervision of E. Denniston, supt.

Mich., River Rouge—City filed application with State Administrative Bd. for Federal aid for waterworks system, incl. 1,600 ft. 20 in. c.i. intake from crib, 4 m.g.p.d. rapid sand filtration plant, 1 m.g. concrete underground clear water reservoir, rein.-con., brick, steel building for filters, pump room and mixing chambers nine 700 to 4,800 g.p.m., motor driven centrifugal pumps, 825 ft. rein.-con. seawall 60,000 cu.yd. fill, timber piling and sheeting, 6,000 ft. 20 in. c.i. water supply line, 1,500 ft. 12 in. c.i. pipe. $380,000. Mason L. Brown & Son, 120 Madison Ave., Detroit, engrs.

Minn., Glenwood—Voted $140,000 bonds for municipal electric light and power plant. J. H. Thoreson, city clk.

Miss., Ellisville—Ellisville Ice Co. plans electric power plant. $70,000.

Mo., Belton—City plans power plant and distribution system. E. T. Archer & Co., 609 New England Bldg., Kansas City, engrs.

Mo., Cape Girardeau—City report presented by Burns & McDonnell Eng. Co., engrs., 107 West Linwood Blvd., Kansas City, and accepted for power plant. $680,000.

Mo., Frederickstown—City estimate and report filed by Burns & McDonnell Eng. Co., engrs., 107 Linwood Blvd., Kansas City, power plant.

Mo., Hayti—City making preliminary studies for light and power plant and distribution system. W. A. Fuller Co., 2916 Shenandoah Ave., St. Louis, consult. engrs.

Mo., Monroe City—City plans extension to and additional equipment for light and power plant. Applied for $60,000 loan under National Industrial Recovery Act. W. B. Rollins & Co., 339 Railway Exch. Bldg., Kansas City, engrs.

Mo., New London—City preliminary surveys completed municipal light and power plant. Will apply for $45,000 loan under P.W.A. W. A. Fuller Co., 2916 Shenandoah Ave., St. Louis, engrs.

Neb., Ord—North Loup Hydro-Electric & Irrigation Dist. plans improving main canal from point about 4 mi. above Taylor to Ord, incl. reservoir and power unit near Sioux Creek, canal on north side of river with diversion dam north of Burwell, power unit at mouth of Gravel Creek and dam near Ord, to be 40 ft. high, 400 ft. long. Filed application for $2,900,000 allotment under National Industrial Recovery Act. Black & Veatch, Mutual Bldg., Kansas City, Mo., consult. engrs.

N. J., Bordentown—City plans lighting plant. $135,000. C. B. Rogers, chn. com.

N. J., Sayreville — Bd. Boro Council, W. Chevalier, in charge, Boro Hall, preliminary plans completed municipal water supply system, incl. pumping station, wells, new equipment. $30,000. Will ask loan under National Industrial Recovery Act. A. T. McMichael, boro engr.

N. D., Enderlin — City voted $101,000 for municipal electric light and power plant. A. B. Anderson, city aud.

O., Cleveland—City, withdrew municipal light plant project from Nov. 7 election. $2,000,000.

O., Defiance—City Council seeking Federal aid for municipal light plant. $350,000. R. Husselman, 310 Hippodrome Bldg., Cleveland, archts. and engrs.

O., Dover—Municipality plans electric power plant and distribution system. $100,000.

O., East Liverpool—City, proposed election Nov. 7, $1,251,891, for power plant ruled out by county election board because of technicalities. Project will be delayed for indefinite period. G. S. Bloomgreen, city engr.

O., Hiram — Village plans municipal light plant (Portage Co.) $31,000. Applied for Federal aid. R. Husselman, 310 Hippodrome Bldg., Cleveland, archt. and engr.

O., Shelby—City, B. Fix, clk., seeking Federal aid for light plant addition (3rd unit). $200,000. Froelich & Emery, 2nd Natl. Bank Bldg., Toledo, engrs.

Okla., Chandler—City plans municipal electric light plant. $130,000. Benham Eng. Co., Kansas City, Mo., engrs. Applied for loan under National Industrial Recovery Act.

Okla., Pawnee—City plans municipal electric light plant. $60,000. Applied for loan under P.W.A.

Pa., Bethlehem—City plans municipal power plant. $125,000. L. L. Fox, City Hall, engr.

Pa., Perkasie—Boro plans addition to electric lighting plant. $55,000. A. C. Wood, 1411 Walnut St., Phila., consult. engr.

Pa., Phila.—Bu. Yards & Docks, Navy Dpt., Wash., D. C., plans power plant equipment, garbage disposal plant, replacing and improving transportation equipment, improving Shipway No. 3, improving buildings and repairing storm damage. $550,000 allotted by P.W.A.

Tex., Pecos—Municipality plans electric power plant. $250,000.

Tex., Plainview — City, c/o R. P. Smith, mayor, filed application for loan under terms National Recovery Act to finance construction water and light plant. $423,346. Montgomery & Ward, Harvey-Snider Bldg., Wichita Falls, engrs.

Tex., Wink—City, c/o S. L. Thedford, filed application for loan with P.W.A. State Bd., to finance construction municipal light plant. $39,690. B. B. Wright, Wink, engr.

Que., Rapide Blanc — Shawinigan Water & Power Co., Rapide Blanc and Montreal, plans additional 80,000 hp. for plant to be completed by May and 160,000 hp. completed for fall of 1934.

Que., St. Hyacinthe—By-law passed and soon takes bids constructing power generating plant. $310,000.

New Zealand, Wellington—Bids Jan. 16, by Secretary Pub. Wks. Supply & Tenders Com., four 1,500 kva. transformers and spares.